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Soil–Vegetation Correlations in the Connecticut River Floodplain of Western Massachusetts

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Preface

The National Ecology Research Center of the U.S. Fish and Wildlife Service (FWS) is supporting a series of field research studies to document relations between hydric soils and wetland vegetation in selected wetlands throughout the United States. This study is one in that series. It is a continuation of the FWS effort, begun by Wentworth and Johnson (1986), to develop a procedure using vegetation to designate wetlands based on the indicator status of wetland vegetation as described by the FWS's *National List of Plant Species that Occur in Wetlands* (Reed 1988). Reed's list classifies all vascular plants of the United States into one of five categories according to their natural frequency of occurrence in wetlands. Concurrent with the development of the wetland plant list, the Soil Conservation Service (SCS) developed the *Hydric Soils of the United States* (United States Department of Agriculture Soil Conservation Service 1987). Studies supported by the National Ecology Research Center quantitatively compare associations of plant species (designated according to their hydric nature using Wentworth and Johnson 1986) with the hydric nature of soils according to their designation on the SCS hydric soils list. The studies are being conducted across moisture gradients at a variety of wetland sites throughout the country. Several studies have been modified to obtain concomitant information on groundwater hydrology.

These studies were conceived in 1984 and implemented in 1985 in response to internal planning efforts of the FWS. To some extent, they parallel ongoing efforts by the SCS to delineate wetlands for Section 1221 of the Food Security Act of 1985 (the so-called swampbuster provision). The SCS and FWS provided joint guidance and direction in the development of the Wentworth and Johnson (1986) procedure, and the SCS has subsequently used a procedure that combines hydric soils and the Wentworth and Johnson procedure for practical wetland delineation.

There are three primary objectives of these studies: to assemble a quantitative data base of wetland plant community dominance and codominance for determining the relation between wetland plants and hydric soils; to test various delineation algorithms based on the indicator status of plants against an independent measure of hydric character, primarily hydric soils; and to test, in some instances, the correlation with groundwater and surface water hydrology.

Any questions or suggestions regarding these studies should be directed to: Charles Segelquist, 4512 McMurray Avenue, Fort Collins, Colorado 80525, phone (303) 226-9384 or FTS 323-5384.

Soil–Vegetation Correlations in the Connecticut River Floodplain of Western Massachusetts

by

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ABSTRACT.—As part of a national study analyzing the relation between hydric soils and wetland vegetation, the vegetation associated with a series of known soils was sampled along the Connecticut River floodplain in Massachusetts. Weighted average and index average (presence/absence) values were calculated for vegetation using wetland ecological index values from the *National List of Plant Species that Occur in Wetlands* developed by the U.S. Fish and Wildlife Service and procedures developed by T. R. Wentworth and G. P. Johnson at North Carolina State University. Good correspondence between soils and vegetation was recorded with two exceptions. Two typically nonhydric soils were determined to be hydric based on vegetation analyses. Examination of the groundwater hydrology of these two soils confirmed their hydric nature. The authors suggested that one of these soils may need to be redefined and they also suggested that the assigned index values for a few species of vegetation should be reexamined. However, in general the index average values of vegetation based on published wetland index values corresponded with the hydric and nonhydric nature of soils.

On floodplains in the northeastern United States, identification of hydric soil characteristics of palustrine wetlands is often complicated, because the soils are young and flooding frequently deposits alluvium or erodes existing soil, resulting in imperfectly developed soils. Consequently, floodplain soils sometimes have poorly developed profiles and are classified as Entisols. Hydric Entisols may lack typical morphological properties generally attributed to hydric soils. An accurate record of the duration and frequency of flooding is not usually available for specific areas, thereby complicating the assessment of hydrologic conditions, although larger rivers may have stream gauge data available from the U.S. Geological Survey or other sources. Vegetation is also affected by flooding. Frequency and duration of flooding play an important part in determining plant community structure. Scouring or deposition during severe flooding may remove or bury much of the herbaceous vegetation, leaving only the more persistent vegetation (e.g., large shrubs and trees). Flooding that is less severe but more frequent and relatively long-term produces an environment favoring development of hydrophytic vegetation.

To facilitate identification and delineation of these floodplain wetlands, the U.S. Fish and Wildlife Service (FWS) contracted for a study of soil–vegetation correlations in the Connecticut River floodplain in western Massachusetts. This study is one of a series of FWS-funded studies designed to assess the relation between hydrophytic vegetation and hydric soils. Specific objectives of our study included (1) testing agreement between hydric soils and hydrophytic vegetation as defined by Wentworth and Johnson (1986); (2) comparing weighted averaging

with index (presence or absence) averaging methods for determining hydrophytic vegetation; (3) evaluating the suitability of values of less than 3.0 for separating hydrophytic vegetation from nonhydrophytic vegetation in a northeastern floodplain; and (4) providing additional information on floodplain plant communities for the northeastern United States.

Literature Review

Several reports describe the relation between vegetation and various environmental factors in the Connecticut River floodplain or in other floodplains in the northeastern United States. Nichols (1916) presented the earliest report on Connecticut River floodplain communities, describing their floristic composition. Warfel and Foote (1939) surveyed vegetation along the Connecticut River in New Hampshire. In western Massachusetts, Sackett (1974, 1977) examined plant community structure and geological development of three abandoned oxbows of the Connecticut River. Holland and Burk (1982) reported on the age of these oxbows. Burk (1977) also documented changes in marsh vegetation over the 4 years following an oil spill. In Connecticut, Metzler and Damman (1985) produced a comprehensive analysis of Connecticut River floodplain vegetation. They found that elevation and location with respect to the river channel were the principal factors responsible for vegetation patterns in the freely drained floodplain. In the sloughs and depressions that retained water after floods, elevation affected flooding frequency, but the vegetation patterns were primarily controlled by water level changes due to evaporation and drainage. Occurrence and timing of summer floods determined the composition and development of the vegetation in any one year. The most striking features of the floodplain forests were the sharp contrasts in species dominance and floristic composition of the ground vegetation and its dramatic annual variations.

Floodplain communities in other major rivers of the Northeast have received some study: Raritan River of New Jersey (Buell and Wistendahl 1955; Wistendahl 1958; Frye and Quinn 1979), Millstone River of New Jersey (Van Vechten and Buell 1959), Allegheny River of New York (Pierce 1981), and Hudson River of New York (McVaugh 1957). Reporting on the wetlands of New Jersey and Delaware, Tiner (1985a, 1985b) briefly discussed floodplain forested wetland communities.

Study Area

The Connecticut River flows 650 km, from southern Quebec in Canada to Long Island Sound in the United States. It is the largest river in New England (Fig. 1) and drains an area of about 29,100 km^2 (Meade 1966). From northern Massachusetts to the mouth of the river, it flows through a broad lowland up to 10 km wide. The active floodplain typically is about 2–3 km across, while the riverbed is up to 750 m wide. Most of the level, better-drained floodplain soils are in cultivation, whereas the hilly uplands are predominantly forested. In the past, a number of cities and towns encroached on the Connecticut River floodplain, but flood disasters increased public awareness of its flood storage function, and floodplain development is now more restricted. During the mid-1800's, several dams were constructed. Turners Falls Dam is in the middle of our study area, and Holyoke Dam lies just to the south.

The Connecticut River valley is underlain by Triassic–Jurassic conglomerates, sandstones, and shales, which may be exposed locally. The surrounding uplands are mostly granite, gneiss, or schists, with a mantle of glacial till up to 20 m thick. The soils formed in recent alluvium are derived mostly from granite, gneiss, schist, shale, and sandstone.

The climate in the study area is primarily continental. Proximity to the Atlantic Ocean and Long Island Sound is a moderating factor (Bradley et al. 1987). The growing season (based on daily average temperature) extends from early March to late November in the southern part of the study area, while in the northern part, it may be about 2 weeks shorter. Daily temperature in summer is about 21° C, and in winter it may fall below –7° C (Bradley et al. 1987). Precipitation averages 1.10 m annually and is distributed evenly throughout the year. Annual snowfall averages about 1.10 m, most of which falls from January through March.

The Connecticut River typically floods in early spring (Hoyt and Langbein 1955) with late spring and early fall flooding fairly common, particularly in the lower landscape positions (Fig. 2). Snow accumulation at higher elevations in Massachusetts, Vermont, and New Hampshire sometimes causes severe flooding during spring thaws; heavy precipitation causes flooding at other times of the year. During periods of low flow, the Connecticut River is subject to freshwater tidal fluctuations (up to 30 cm in Hartford; Metzler and Damman 1985). The river is tidal to Windsor Locks, Connecticut.

The Connecticut River is strongly meandering, with evidence of channel diversions, such as open oxbow lakes, possibly dating to 1840 (Holland and Burk 1982). Natural levees containing coarser-textured deposits often line the current channel, while older levees occur farther away from the present riverbed. Terraces are also evident. Jahns (1947) described five terraces, or floodplain levels, with only the lower two levels still being inundated. The upper level floods only for short periods during extreme floods, whereas the lowest level is inundated annually for much longer periods.

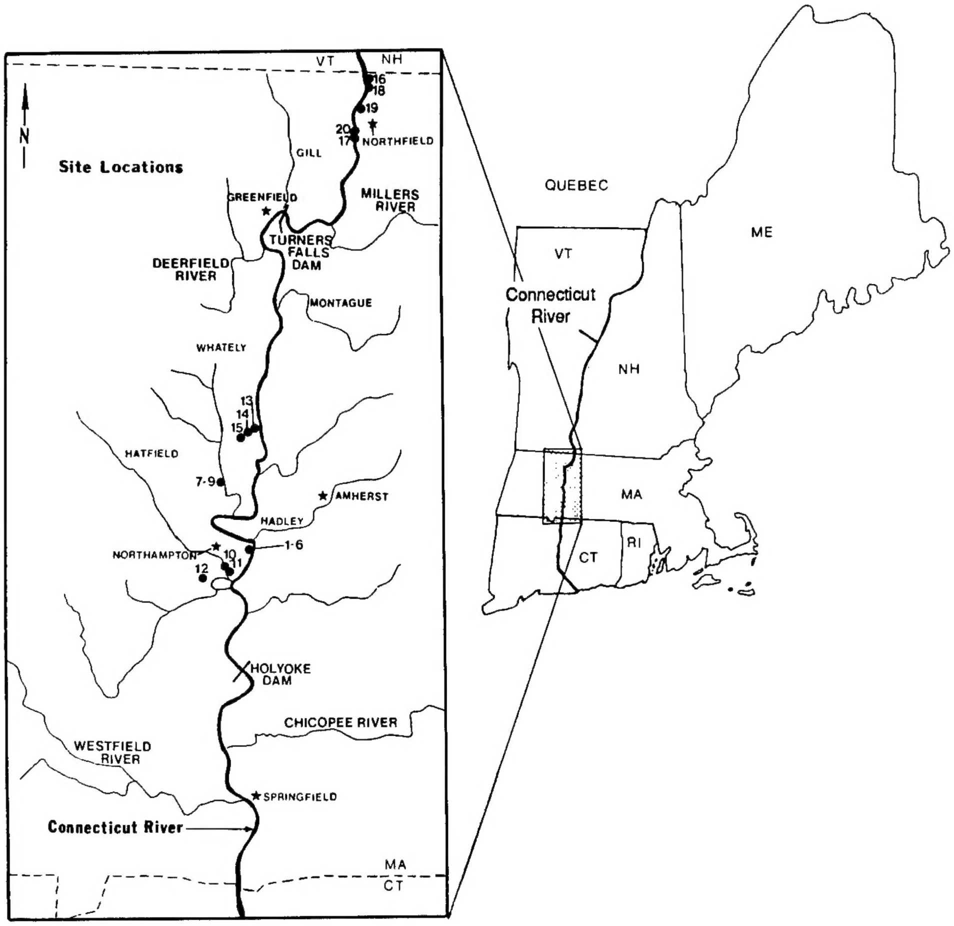

Fig. 1. Location of the study area and sampling sites.

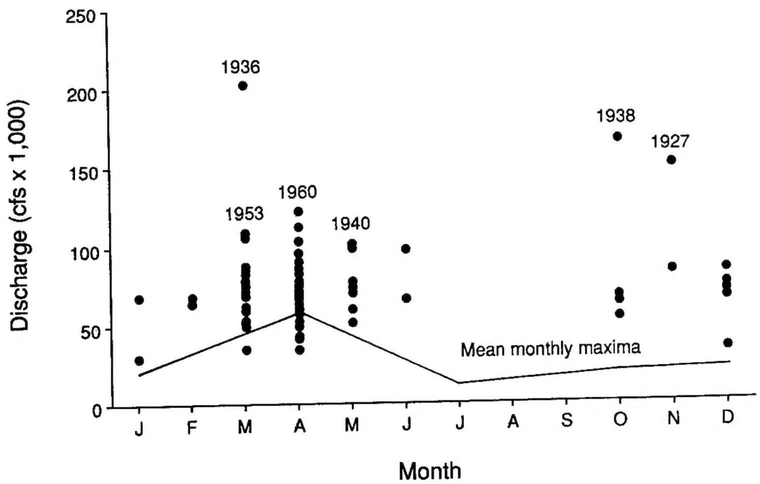

Fig. 2. Monthly peak discharge rates of the Connecticut River at Turners Falls Dam, Montague, Massachusetts, for 1914–88.

Methods

General

Twenty sites were selected in the central and northern sections of the Massachusetts part of the Connecticut River floodplain (Fig. 1). We used three criteria for site selection: the presence of natural vegetation, soil series characteristics, and the availability of an area large enough to accommodate random selection of sample plots. Plots were selected randomly, and the vegetation and soils were evaluated in each plot. In addition, hydrologic observations were made at each site at regular intervals.

Site Selection

The first step in site selection was choosing a representative sequence of soils, based on differences in drainage class (hydrosequence) and consisting of moderately well-drained, somewhat poorly drained, and poorly to very poorly drained members. Existing soil survey reports were used in combination with National Wetlands Inventory maps to locate potential study sites. Floodplain soils in Hampshire County (Swenson 1981) were reported to have silty textures, while farther north, in Franklin County, sandier soils were prevalent (Mott and Fuller 1967). In the course of our fieldwork, however, we found that coarse-loamy soils in Franklin County were the exception rather than the rule, and only a few suitable undisturbed sites could be located. In addition, only a few well-drained sites (Hadley series) with natural vegetation were identified. Naturally vegetated, well-drained sites are not common in the Connecticut River valley because most Hadley silt loams have been cultivated.

After the general site for a particular soil type was selected, five sampling plots were randomly selected and the center of each plot determined. A total of 100 plots was sampled.

Soil Characterization

Soil borings made along the perimeter of each plot ensured homogeneity of the soil within the sampling site, and a representative sample was chosen to describe the soil profile at each site. A 1-m^3 pit was excavated, and the soil was described and classified in accordance with standard methods (Soil Survey Staff 1951, 1988). Micromorphological phenomena were described using the terminology of Brewer (1976).

Hydric soils were identified following technical criteria established by the National Technical Committee for Hydric Soils (Table 1). Soil morphological properties and available hydrologic data determined whether a given soil met the hydric soil criteria. Information concerning field indicators of hydric soils in New England was presented in Tiner and Veneman (1989).

Table 1. *Technical criteria for hydric soils (adapted from USDA Soil Conservation Service 1987).*

1. All organic soils (Histosols) except Folists, or
2. Mineral soils in Aquic suborders, Aquic subgroups, Albolls surborder, Salorthids great group, or Pell great groups of Vertisols that are:
   a. somewhat poorly drained and have a water table <15 cm (6 inches) from the surface for a significant period (usually a week or more) during the growing season, or
   b. poorly drained or very poorly drained and have either: (1) a water table at <30 cm (12 inches) from the surface for a significant period (usually a week or more) during the growing season if permeability is ≥15 cm/h (6 inches/h) in all layers within 50 cm (20 inches), or (2) water table at <45 cm (18 inches) from the surface for a significant period (usually a week or more) during the growing season if permeability is <15 cm/h (6 inches/h) in any layer within 50 cm (20 inches), or
3. Mineral soils that are ponded for long duration (>7 days) or very long duration (more than a month) during the growing season, or
4. Mineral soils that are frequently flooded for long duration (>7 days) or very long duration (more than a month) during the growing season.

Vegetation Sampling

Vegetation was sampled at 20 sites during summer months from May 1987 through July 1988. In five plots at each site, vegetation in three strata was analyzed: tree stratum (woody vegetation >7.5 cm diameter at breast height, or dbh), shrub stratum (woody vegetation ≤7.5 cm dbh and ≥50 cm), and herb stratum (nonwoody plants, including seedlings <50 cm tall of woody species). Woody vines were present (mostly grape, *Vitis* sp.) but uncommon, and they were not included in the analysis. Scientific nomenclature follows the *National List of Scientific Plant Names* (USDA Soil Conservation Service 1982).

For each study site, the tree plot was 100 m^2. Plot size for analyzing the shrub stratum varied—from the entire tree plot (100 m^2 for sites 1–7 and 9–12) to a subplot of 25 m^2 nested within the tree plot (sites 8 and 13–20). At site 8, plot 1, a dense alder thicket forced us to reduce the shrub plot to 12.5 m^2. In most plant communities of the lower floodplain, the shrub stratum was sparse due to frequent scouring and inundation, so a larger shrub plot (100 m^2) was used in most cases. Herbaceous vegetation was analyzed in two 0.5-m^2 plots nested within each tree plot.

Diameter at breast height was recorded for all trees and shrubs within the plots. Basal area was calculated for each woody plant using the formula

$$A = \frac{\pi d^2}{4}$$

where A is basal area, π is 3.1416, and d is diameter at breast height. Total basal area was calculated for each woody species by totaling the basal areas of the individual plants. Stem densities of trees and shrubs were also recorded.

Areal coverage by herb species was estimated visually. Estimates were then placed in cover classes as defined by Daubenmire (1968), and midpoint values of the cover classes were used for calculations (Table 2). Stem counts were also made to determine density of herbs.

Table 2. *Daubenmire (1968) cover classes for evaluating the herb stratum.*

Cover class	Range of percent cover	Midpoint cover value
1	0–5	2.5
2	6–25	15.0
3	26–50	37.5
4	51–75	62.5
5	76–95	85.0
6	96–100	98.0

Vegetation Data Analysis

The wetland indicator status for each species sampled was recorded from Reed (1988). There are five indicator categories: (1) obligate wetland (OBL: species that almost always occur in wetlands [probability >99%] under natural conditions); (2) facultative wetland (FACW: species usually occuring in wetlands [probability 67–99%] but occasionally found in nonwetlands [probability 1–33%]); (3) facultative (FAC: species equally likely to occur in wetlands or nonwetlands [probability 34–66%]); (4) facultative upland (FACU: species frequently occurring in nonwetlands [probability 67–99%] but occasionally found in wetlands [probability 1–33%]); and (5) obligate upland (UPL: species that almost always occur in nonwetlands [probability >99%]).

Dominant species for each stratum were determined. Herb dominance was based on percent cover, and tree and shrub dominance were determined by basal area. Dominant species were defined according to the new Federal wetland delineation manual (Federal Interagency Committee for Wetland Delineation 1989).

To assess the hydrophytic nature of the vegetation, weighted averages and index averages were calculated for each stratum using information in Wentworth and Johnson (1986). For all strata combined, the individual scores were averaged.

Weighted average was determined using the formula

$$W_j = \frac{\sum_{i=1}^{p} I_{ij} E_i}{\sum_{i=1}^{p} I_{ij}}$$

where

W_j = weighted average for plot j,
I_{ij} = importance value for species i in plot j,
E_i = ecological indicator value for species i, and
p = number of species in plot j.

Ecological indicator values were assigned to each wetland indicator status: 1 = OBL, 2 = FACW, 3 = FAC, 4 = FACU, and 5 = UPL. Importance values were percent cover for herbs and basal area for shrubs and trees. Index averages were calculated using the formula

$$I_j = \frac{\sum_{i=1}^{p} E_i}{p}$$

where

I_j = index average for plot j,
E_i = ecological index for species i, and
p = number of species in plot j.

For this study, hydrophytic vegetation was defined by a weighted average or an index average of <3.0. Therefore, any community or stratum having an average value ≥3.0 was not considered hydrophytic. (In general, the 3.0 value may be a useful breakpoint for separating hydrophytic vegetation from nonhydrophytic vegetation, but it is not without exceptions—see Federal Interagency Committee for Wetland Delineation 1989.)

Hydrologic Data Collection

Soil–vegetation studies are often hampered by the lack of reliable hydrologic information. For this study, hydrologic characteristics (approximate frequency and duration of flooding and water table fluctuations) were determined by direct observations using well points.

Well points were constructed from 3.8-m diameter PVC pipe. The lower 90 cm of each pipe were perforated by drilling 0.5-cm holes, and this section was wrapped in engineering cloth to prevent soil from clogging the holes. The wells were between 2 and 3 m deep and were installed in pairs at each site by augering a hole slightly larger in diameter than the pipe and backfilling the space between the pipe and borehole with the original soil material. The upper 20 cm of this cavity was sealed with Bentonite to prevent surface water from entering the wells. Wells were installed at each site during the summer of 1988, and we began taking measurements in September 1988. Readings were taken at 2-week intervals and usually weekly during flooding events.

Results

Soils

Six soil series were studied: (1) Saco (seven sites), (2) Limerick (six sites), (3) Rippowam (one site), (4) Winooski (three sites), (5) Pootatuck (one site), and (6) Hadley (two sites). Detailed soil profile and series descriptions are provided in Appendixes A and B. Soil classification and site-specific information are summarized in Table 3. All very poorly drained Saco soils met the hydric soil criteria (USDA Soil Conservation Service 1987), whereas the well-drained Hadley soils were always nonhydric. Two of the Limerick soils (sites 1 and 4) were nonhydric, whereas most of these somewhat poorly drained soils met the hydric soil criteria. Moderately well-drained soils generally are not considered hydric; however, the Winooski soil at site 12 had sufficient low chroma colors (Tiner and Veneman 1987) and wetland hydrology to be hydric.

Vegetation

General

Sixteen of the 20 sites studied were forested. Sites 8 (Rippowam) and 19 (Saco) were shrub thickets, while sites 7 (Saco) and 18 (Limerick) were marshes with occasional shrubs and trees, particularly at site 18.

A total of 122 species was identified in the sample plots: 28 tree species (4 of which occurred only in the herb or shrub strata), 22 shrub species (4 of which occurred only in the herb stratum), and 72 herb species (Table 4). Nearly half (13 species) of the tree species were FACU, while nearly equal numbers of FAC (7) and FACW (6) tree species were observed. Only two UPL tree species, staghorn sumac (*Rhus typhina*) and American chestnut (*Castanea dentata*), were recorded, and no OBL trees were present. For shrubs, nine species were FACW and seven were FAC; the remaining six species consisted of one OBL species, buttonbush (*Cephalanthus occidentalis*); three FACU species, mountain laurel (*Kalmia latifolia*),

Table 3. *Soil classification, drainage class, and hydric status for each site in the Connecticut River valley, western Massachusetts. See Table 1 for definitions of hydric soil criteria.*

Site	Soil series	Classification	Family[b]	Drainage class	Hydric criterion	Location
1	Limerick	Aeric Fluvaquent	CSi,mi,n,m	somewhat poorly drained	—	Northampton, Rainbow Beach south
2	Limerick*[a]	Aeric Fluvaquent	CSi,mi,n,m	somewhat poorly drained	4	Northampton, Rainbow Beach south
3	Saco*	Typic Fluvaquent	CSi,mi,n,m	very poorly drained	2B2	Northampton, Rainbow Beach south
4	Limerick	Aeric Fluvaquent	CSi,mi,n,m	somewhat poorly drained	—	Northampton, Rainbow Beach north
5	Limerick*	Aeric Fluvaquent	CSi,mi,n,m	somewhat poorly drained	2A,4	Northampton, Rainbow Beach north
6	Saco*	Typic Fluvaquent	CSi,mi,n,m	very poorly drained	2B2,4	Northampton, Rainbow Beach north
7	Saco*	Fluvaquentic Humaquept	CSi,mi,n,m	very poorly drained	2B2,4	W. Hatfield
8	Rippowam*	Aeric Fluvaquent	CL,mi,n,m	poorly drained	2B2,4	W. Hatfield
9	Pootatuck[c]	Fluvaquentic Dystrochrept	CL,mi,m	moderately well-drained	—	W. Hatfield
10	Limerick*	Aeric Fluvaquent	CSi,mi,n,m	poorly drained	2B2,4	Northampton, Manhan—east
11	Saco*	Fluvaquentic Humaquept	CSi,mi,n,m	very poorly drained	2B2,4	Northampton, Manhan—west
12	Winooski*	Aquic Udifluvent	CSi,mi,n,m	moderately well-drained	4	Northampton, Pynchon
13	Winooski	Aquic Udifluvent	CSi,mi,n,m	moderately well-drained	—	Whately, Pilgrim Airport
14	Saco*	Fluvaquentic Humaquept	CSi,mi,n,m	very poorly drained	2B2,4	Whately, Pilgrim Airport
15	Saco*	Fluvaquentic Humaquept	CSi,mi,n,m	very poorly drained	2B2,4	Whately, Pilgrim Airport
16	Hadley	Typic Udifluvent	CSi,mi,n,m	well-drained	—	Northfield, Rt. 63
17	Winooski	Aquic Udifluvent	CSi,mi,n,m	moderately well-drained	—	Gill, Mount Hermon
18	Limerick*	Aeric Fluvaquent	CSi,mi,n,m	somewhat poorly drained	2B2,4	Northfield, Pauchaug Brook
19	Saco*	Fluvaquentic Humaquept	CSi,mi,n,m	very poorly drained	2B2,4	Northfield, west of Center
20	Hadley	Typic Udifluvent	CSi,mi,n,m	well-drained	—	Gill, Mount Hermon

[a]* = hydric soil.
[b]Particle size classes: CSi = Coarse-silty; CL = coarse-loamy; mi = mixed mineralogy; n = nonacid; m = mesic soil temperature regime (Soil Survey Staff 1988).
[c]This is a variant due to the silt loam texture in the upper 33 cm.

Table 4. *Presence of plant species at the sampling sites in the Connecticut River valley, western Massachusetts. (Wetland indicator status for each species identified according to Reed 1988.)*[a]

	Hydric soils site number													Nonhydric soils site number						
Indicator Status	3S	6S	7S	11S	14S	15S	19S	8R	2L	5L	10L	18L	12W	1L	4L	13W	17W	9P	16H	20H
OBL																				
Alisma plantago-aquatica							h													
Angelica atropurpurea												h								
Carex lupulina				h			h	h						h						
Carex lurida							h													
Carex stricta												h								
Cephalanthus occidentalis				s			hs													
Galium asprellum			h				h					h								
Galium tinctorum			h																	
Glyceria canadensis			h																	
Glyceria striata								h						h						
Lycopus uniflorus	h					h	h													
Lysimachia nummularia							h													
Lysimachia terrestris				h																
Osmunda regalis				h									h							
Polygonum sagittatum			h				h													
Sagittaria latifolia								h												
Symplocarpus foetidus																	h			
FACW+																				
Alnus rugosa			ts	h				hs			st		h							
Boehmeria cylindrica	h	h	h	h			h		h	h			h							
Carex tribuloides							h													
Cinna arundinacea								h					h	h	h					
Cornus stolonifera							hs					s								
Ilex verticillata				s	s	s							hs			h	s			hs
Phalaris arundinacea	h			h			h													
Quercus bicolor																	h		h	h
Salix nigra	t	t					t			t										
Scirpus cyperinus			h																	
Scutellaria lateriflora	h																			
Thalictrum pubescens								h			h	h	h							
Thelyptheris thelypteroides				h								h								
FACW																				
Acer saccharinum	ths	ts		hst					ht		ts	ts	t	ht	t					
Apios americana				h			h						h							
Aronia arbutifolia					h															
Cornus amomum			s	s			hs	s				s	s							
Eupatoriadelphus maculatus			h																	
Fraxinus pennsylvanica				s							st		st				ht			ht
Impatiens capensis	h	h	h			h	h	h	h	h	h		h	h					h	
Laportea canadensis		h							h	h			h	h	h					
Leersia virginica	h			h					h	h				h						
Matteuccia struthiopteris			h						h						h					
Onoclea sensibilis	h		h	h			h	h			h	h	h				h		h	
Osmunda cinnamomea					h	h		h					h				h	h		
Pilea pumila										h										

Table 4. *Continued.*

Indicator Status	Hydric soils site number													Nonhydric soils site number						
	3S	6S	7S	11S	14S	15S	19S	8R	2L	5L	10L	18L	12W	1L	4L	13W	17W	9P	16H	20H
Quercus palustris				ht	t	t							ht			t				
Rubus hispidus								h									hs		h	h
Viburnum cassinoides					s	s							s							
Vitis riparia							h													
FACW–																				
Arisaema triphyllum							h				h		h	h					h	h
Sambucus canadensis		s					h	h			s	s	hs	s			s			
Ulmus americana		t	st	st		t	s		hst	t	st	st	h	ht	t		t		s	
Vaccinium corymbosum					s	s							s			s		s		
Viburnum recognitum					s	s		hs												
FAC+																				
Acer negundo										ht										
Dryopteris spinulosa						h											h			
Geum laciniatum											h									
Spiraea latifolia			s			h	s	hs												
FAC																				
Acer rubrum			t	hst	t	hst		hs					t			t	ts		hst	st
Amelanchier arborea					s	s														hs
Amphicarpa bracteata														h						
Aronia melanocarpa																			h	
Athyrium filix-femina													h							
Betula alleghaniensis																		st		
Betula populifolia				t		t										t		s		t
Carpinus caroliniana																		h		
Clematis virginiana												h								
Kalmia angustifolia					h											h	h			
Nyssa sylvatica					h	h														
Polygonum scandens							h													
Populus deltoides	t	t							ts	t				t						
Rubus idaeus																			h	
Smilax herbacea				h									h				h			
Solidago rugosa								h												
Thelypteris noveboracensis																		h		
Toxicodendron radicans	h			h							h						h		h	h
Trientalis borealis																	h	h	h	h
Ulmus rubra																t				
Viburnum dentatum				h	h															
Viburnum lentago																				s
FAC–																				
Hamamelis virginiana																hst	s	hst		
Maianthemum canadense					h												h	h	h	h
Solanum dulcamara							h			h										
FACU+																				
Carya cordiformis																	s		hs	hst
FACU																				
Acer pensylvanicum																	s			
Aralia nudicaulis					h											h			h	h
Berberis thunbergii																	hs			s
Betula papyrifera																	t		s	
Circaea lutetiana																	h			h
Fraxinus americana				st													st	h	s	st
Galium triflorum								h												

Table 4. *Continued.*

	Hydric soils site number													Nonhydric soils site number						
Indicator Status	3S	6S	7S	11S	14S	15S	19S	8R	2L	5L	10L	18L	12W	1L	4L	13W	17W	9P	16H	20H
Gaultheria procumbens					h											h				
Kalmia latifolia																hs		s		
Lycopodium obscurum					h											h		h	h	
Mitchella repens																		h		
Parthenocissus quinquefolia																	h		h	h
Pinus strobus																	t		s	t
Polygonatum biflorum																			h	
Populus tremula													st							t
Prunus serotina						s											h	s	hst	hs
Pteridium aquilinum					h											h				
Vitis labrusca				h																
FACU–																				
Acer saccharum																	st	t	s	hst
Carya glabra																			h	
Carya ovata																	st	st		
Cornus florida																	s		hst	
Polystichum acrostichoides																		h		
Populus grandidentata																t				t
Quercus alba																t	hs		st	
Quercus rubra						h										t	s	st	st	
Rubus allegheniensis																			h	
Smilacina racemosa																			h	h
Trillium erectum																	h			
Uvularia sessilifolia													h							
UPL																				
Apocynum medium						h														
Asclepias syriaca												h								
Aster schreberi																	h			h
Castanea dentata																	s			
Cornus alternifolia																				h
Dennstaedtia punctilobula					h	h										h	h		h	
Medeola virginiana					h															
Pyrola elliptica																h				
Rhus typhina																			t	
Rubus flagellaris					h	h		h												
Rubus occidentalis																	h		h	
Viburnum acerfolium																		h	hs	

[a]Strata: h = herb, s = shrub, and t = tree. Soils listed as hydric or nonhydric, with sample site numbers and soil series (by letter: H = Hadley, L = Limerick, P = Pootatuck, R = Rippowam, S = Saco, and W = Winooski).

Japanese barberry (*Berberis thunbergii*), and flowering dogwood (*Cornus florida*); and two UPL species, maple-leaf viburnum (*Viburnum acerifolium*) and alternate-leaf dogwood (*Cornus alternifolia*). About 28% (20 species) of the herb species were FACW, with nearly equal presence by OBL species (15), FACU species (15), and FAC species (14). Eight UPL herb species were recorded.

Forty-five species were recorded only on hydric soil, and 39 species were restricted to nonhydric soil (Table 4). Several skunk cabbage (*Symplocarpus foetidus;* OBL) plants were recorded only on a nonhydric Winooski soil (site 17). This species was not found in any plots at other sample sites in the study area, although it was seen on the hydric Rippowam soil near site 8. Four UPL species

were found growing only at hydric soil sites: northern or prickly dewberry (*Rubus flagellaris*), intermediate dogbane (*Apocynum medium*), common milkweed (*Asclepias syriaca*), and Indian cucumber-root (*Medeola virginiana*). Of these, numerous individuals of *R. flagellaris* occurred on the Rippowam soil (site 8) and two Saco soils (sites 14 and 15), while only one or two individuals of the other species were observed at one site only. Another UPL species, hay-scented fern (*Dennstaedtia punctilobula*), occurred on both hydric and nonhydric soils (Saco, Winooski, and Hadley).

Among those species occurring only on hydric soils, the following species were found at three or more sites: false nettle (*Boehmeria cylindrica;* 8 sites), speckled alder (*Alnus rugosa;* 5 sites), black willow (*Salix nigra;* 4 sites), broad-leaved meadowsweet (*Spiraea latifolia;* 4 sites), tall meadow-rue (*Thalictrum pubescens;* 4 sites), northern arrowwood (*Viburnum recognitum;* 3 sites), reed canary grass (*Phalaris arundinacea;* 3 sites), northern bugleweed (*Lycopus uniflorus;* 3 sites), rough bedstraw (*Galium asprellum;* 3 sites), northern dewberry (3 sites), and groundnut (*Apios americana;* 3 sites). Seventeen FACW species and 13 OBL species represented about 66% of the plant species limited to hydric soils.

The most frequently occurring species restricted to nonhydric soils were white ash (*Fraxinus americana;* 4 sites), sugar maple (*Acer saccharum;* 4 sites), star-flower (*Trientalis borealis;* 4 sites), white oak (*Quercus alba;* 3 sites), eastern white pine (*Pinus strobus;* 3 sites), bitternut hickory (*Carya cordiformis;* 3 sites), witch hazel (*Hamamelis virginiana;* 3 sites), Virginia creeper (*Parthenocissus quinquefolia;* 3 sites), and false Solomon's-seal (*Smilacina racemosa;* 3 sites). Nearly 70% of the species found only on nonhydric soils were FACU and UPL species, with more than half of those (20 species) represented by FACU species alone.

Species richness differed markedly among the 20 sites (Table 5), ranging from a low of 5 species at the nonhydric Limerick soil (site 4) to 37 species at the nonhydric Winooski soil (site 17). When averaged, the Limerick soils had the lowest species richness (average of 6 sites = 10 species), while the well-drained Hadley soils had the highest (average of 2 sites = 30). Table 6 shows the distribution of species of similar wetland indicator status at each soil site by stratum. In general, the herb stratum had the greatest species richness.

Dominant species for each stratum and site for different soil types are presented in Table 7. Dominance was defined according to the Federal Interagency Committee for Wetland Delineation (1989): "Dominant species are the most abundant plant species (when ranked in descending order of abundance and cumulatively totaled) that immediately exceed 50 percent of the total dominance measure (e.g., basal area or areal coverage) for the stratum, plus any additional species comprising 20 percent or more of the total dominance measure for the stratum."

Table 5. *Species richness for different soil types at each sampling site.*[a]

Soil series	Site	Drainage class[b]	Number of plant species
SACO*	6	VPD	9
	3	VPD	11
	7	VPD	15
	14	VPD	17
	15	VPD	22
	11	VPD	23
	19	VPD	25
RIPPOWAM*	8	PD	18
LIMERICK*	2	SPD	8
	5	SPD	11
	10	PD	11
	18	SPD	13
WINOOSKI*	12	MWD	23
LIMERICK	4	SPD	5
	1	SPD	12
WINOOSKI	13	MWD	16
	17	MWD	37
POOTATUCK	9	MWD	20
HADLEY	20	WD	27
	16	WD	33

[a]* = hydric soil.
[b]Drainage classes: VPD = very poorly drained; PD = poorly drained; SPD = somewhat poorly drained; MWD = moderately well-drained; WD = well-drained.

Weighted averages and index averages for each stratum and for all strata combined for each soil series and site are presented in Table 8. Averages for each stratum at each site are shown in Appendix C. The nonhydric Limerick soil of the active floodplain at Northampton had the lowest weighted average and index average in each stratum and for all strata combined. The next lowest averages for all strata combined were for the hydric Limerick soil and the hydric Rippowam soil. With the exception of the nonhydric Limerick soil, there was good correlation between hydric soils and hydrophytic vegetation (i.e., weighted and index average mean values <3.0) when all strata were combined. When each stratum was examined independently, there was good correlation between soil and vegetation at most sites. The herb stratum had a relatively good but somewhat weaker correlation than the tree and shrub strata at individual sites (Tables C-1–C-3).

Tree Stratum

There was generally good separation between hydric and nonhydric soils, following the definition of hydrophytic vegetation tested in this study. Most plant communities having weighted or index average mean values >3.0 were associated with nonhydric soils, whereas most communities with values <3.0 were found on hydric soils. Even the hydric Winooski soil had hydrophytic vegetation

Table 6. *Distribution of plant species by wetland indicator status categories and vegetative stratum at each sampling site.*

Soil type (drainage class)[a]	Site	Stratum	Number of species by wetland indicator status[c]					Total
			OBL	FACW	FAC	FACU	UPL	
Saco*[b] (VPD)	3	Tree	—	2	1	—	—	3
		Shrub	—	1	—	—	—	1
		Herb	1	7	1	—	—	9
	6	Tree	—	3	1	—	—	4
		Shrub	—	2	—	—	—	2
		Herb	—	4	—	—	—	4
	7	Tree	—	1	—	—	—	1
		Shrub	—	3	2	—	—	5
		Herb	4	6	—	—	—	10
	11	Tree	—	3	2	—	—	5
		Shrub	1	6	2	—	—	9
		Herb	3	7	4	1	—	15
	14	Tree	—	1	1	—	—	2
		Shrub	—	5	3	—	—	8
		Herb	—	1	1	4	2	8
	15	Tree	—	2	3	—	—	5
		Shrub	—	5	2	1	—	8
		Herb	1	2	5	2	2	12
	19	Tree	—	2	—	—	—	2
		Shrub	1	2	1	—	—	4
		Herb	7	11	2	1	1	22
Limerick* (SPD, PD)	2	Tree	—	2	1	—	—	3
		Shrub	—	2	1	—	—	3
		Herb	—	6	—	—	—	6
	5	Tree	—	3	2	—	—	5
		Shrub	—	1	—	—	—	1
		Herb	—	5	1	—	—	6
	10	Tree	—	4	—	—	—	4
		Shrub	—	5	—	—	—	5
		Herb	—	4	2	—	—	6
	18	Tree	—	2	—	—	—	2
		Shrub	—	5	—	—	—	5
		Herb	3	3	1	—	1	8
Rippowam* (PD)	8	Tree	—	1	—	—	—	1
		Shrub	—	3	2	—	—	5
		Herb	3	7	2	1	1	14
Winooski* (MWD)	12	Tree	—	3	1	1	—	5
		Shrub	—	5	—	1	—	6
		Herb	1	12	2	1	—	16
Limerick (SPD)	1	Tree	—	2	1	—	—	3
		Shrub	—	1	—	—	—	1
		Herb	2	6	1	—	—	9
	4	Tree	—	2	—	—	—	2
		Shrub	—	1	—	—	—	1
		Herb	—	3	—	—	—	3
Winooski (MWD)	13	Tree	—	1	2	3	—	6
		Shrub	—	1	2	1	—	4
		Herb	—	1	2	6	1	10

Table 6. *Continued.*

Soil type (drainage class)[a]	Site	Stratum	Number of species by wetland indicator status[c] OBL	FACW	FAC	FACU	UPL	**Total**
	17	Tree	—	1	1	8	—	10
		Shrub	—	4	2	9	1	16
		Herb	1	6	5	7	4	23
Pootatuck (MWD)	9	Tree	—	—	1	4	—	5
		Shrub	—	1	4	5	1	11
		Herb	—	1	4	4	—	9
Hadley (WD)	16	Tree	—	—	1	5	—	6
		Shrub	—	1	1	8	1	11
		Herb	—	5	6	10	3	24
	20	Tree	—	—	2	5	—	7
		Shrub	—	1	3	5	—	9
		Herb	—	4	4	9	3	20

[a]Drainage classes: VPD = very poorly drained; PD = poorly drained; SPD = somewhat poorly drained; MWD = moderately well-drained; WD = well-drained.
[b]* = hydric soil.
[c]Wetland indicator status categories: OBL = obligate wetland species; FACW = facultative wetland species; FAC = facultative species; FACU = facultative upland species; UPL = upland species.

Table 7. *Dominant vegetation by stratum for each site. Dominant species are defined according to the* Federal Manual for Identifying and Delineating Jurisdictional Wetlands *(Federal Interagency Committee for Wetland Delineation 1989). Wetland indicator status for each species is according to Reed (1988).*[a]

Indicator status	Hydric soils site number 3S	6S	7S	11S	14S	15S	19S	8R	2L	5L	10L	18L	12W	Nonhydric soils site number 1L	4L	13W	17W	9P	16H	20H
OBL																				
Carex lurida							h													
Glyceria striata								h												
Lycopus uniflorus	h																			
FACW+																				
Alnus rugosa			s					st												
Boehmeria cylindrica	h								h	h										
Carex tribuloides							h													
Ilex verticillata						s							s							
Phalaris arundinacea			h				h													
Salix nigra	t						t													
FACW																				
Acer saccharinum	st	st							st	st	t	t	t	t	st					
Cornus amomum							s					s								
Fraxinus pennsylvanica											st		st							
Impatiens capensis	h							h					h							

Table 7. *Continued.*

	Hydric soils site number													Nonhydric soils site number						
Indicator status	3S	6S	7S	11S	14S	15S	19S	8R	2L	5L	10L	18L	12W	1L	4L	13W	17W	9P	16H	20H
Laportea canadensis		h							h	h				h	h					
Leersia virginica														h						
Matteuccia struthiopteris		h							h											
Onoclea sensibilis				h			h	h			h	h	h							
Osmunda cinnamomea						h											h			
Quercus palustris				t		t							t							
Rubus hispidus																			h	
Viburnum cassinoides					s															
Vitis riparia							h													
FACW–																				
Arisaema triphyllum													h							
Sambucus canadensis														s						
Ulmus americana			st	s								st								
Viburnum recognitum						s														
FAC+																				
Dryopteris spinulosa																	h			
FAC																				
Acer rubrum			s	s	t	t		t					t			t	st		t	st
Amelanchier arborea					s															
Populus deltoides	t								t	t										
Thelypteris noveboracensis																		h		
Toxicodendron radicans																			h	h
FAC–																				
Hamamelis virginiana																s		s		
Maianthemum canadense																	h		h	h
FACU																				
Acer pensylvanicum																	s			
Aralia nudicaulis																			h	h
Fraxinus americana																	t			t
Gaultheria procumbens					h											h				
Kalmia latifolia																s				
Lycopodium obscurum					h											h				
Parthenocissus quinquefolia																				h
Pinus strobus																			t	
Populus tremula																				t
Prunus serotina																			s	
FACU–																				
Acer saccharum																	s	st		s
Quercus rubra																t				
Smilacina racemosa																			h	h
UPL																				
Dennstaedtia punctilobula							h													
Pyrola eliptica																h				
Rubus flagellaris									h											h

[a]Strata: h = herb; s = shrub; t = tree.
[b]Soils listed as hydric or nonhydric, with sample site numbers and soil series (H = Hadley; L = Limerick; P = Pootatuck; R = Rippowam; S = Saco; W = Winooski).

Table 8. *Weighted averages and index averages (mean values) for each stratum and all strata combined by soil series, separating hydric from nonhydric members when appropriate.*

Soil type (drainage class[a])	Number of sites/samples	Stratum	Weighted average mean (std. error)	Index average mean (std. error)
Saco*[b] (VPD)	7/35	Tree	2.39 (0.09)	2.40 (0.09)
	7/35	Shrub	2.10 (0.04)	2.18 (0.05)
	7/70	Herb	2.51 (0.17)	2.50 (0.15)
		All	2.31 (0.08)	2.33 (0.08)
Rippowam* (PD)	1/5	Tree	2.33 (0.33)	2.33 (0.33)
	1/5	Shrub	2.06 (0.02)	2.30 (0.08)
	1/10	Herb	2.07 (0.07)	2.18 (0.17)
		All	2.12 (0.09)	2.26 (0.13)
Limerick* (SPD)	4/20	Tree	2.26 (0.08)	2.21 (0.06)
	4/20	Shrub	2.09 (0.07)	2.09 (0.07)
	4/40	Herb	2.00 (0.01)	2.02 (0.04)
		All	2.12 (0.03)	2.11 (0.04)
Winooski* (MWD)	1/5	Tree	2.33 (0.11)	2.45 (0.13)
	1/5	Shrub	2.08 (0.05)	2.18 (0.11)
	1/10	Herb	2.03 (0.03)	2.23 (0.08)
		All	2.15 (0.05)	2.29 (0.06)
Limerick (SPD)	2/10	Tree	2.13 (0.13)	2.13 (0.13)
	2/10	Shrub	2.00 (0.00)	2.00 (0.00)
	2/20	Herb	2.00 (0.00)	1.98 (0.02)
		All	2.05 (0.05)	2.03 (0.05)
Winooski (MWD)	2/10	Tree	3.48 (0.11)	3.58 (0.09)
	2/10	Shrub	3.54 (0.10)	3.33 (0.08)
	2/20	Herb	3.54 (0.18)	3.46 (0.18)
		All	3.52 (0.08)	3.46 (0.05)
Pootatuck (MWD)	1/5	Tree	3.98 (0.02)	3.90 (0.10)
	1/5	Shrub	3.33 (0.13)	3.52 (0.10)
	1/10	Herb	3.00 (0.08)	3.09 (0.15)
		All	3.44 (0.06)	3.50 (0.10)
Hadley (WD)	2/10	Tree	3.57 (0.14)	3.50 (0.13)
	2/10	Shrub	3.81 (0.12)	3.80 (0.08)
	2/20	Herb	3.61 (0.13)	3.57 (0.09)
		All	3.66 (0.06)	3.62 (0.05)

[a]Drainage classes: VPD = very poorly drained; PD = poorly drained; SPD = somewhat poorly drained; MWD = moderately well-drained; WD = well-drained.
[b]* = hydric soil.

(this series is typically nonhydric). The notable exception to the general tendency was the nonhydric Limerick soil (sites 1 and 4) on the active floodplain of the Connecticut River in Northampton. This soil is flooded annually for brief periods (i.e., <1 week) during the growing season, yet not long enough to be hydric. The tree species, however, were all hydrophytic, with silver maple (*Acer saccharinum;* FACW) predominating and American elm (*Ulmus americana;* FACW−) and eastern cottonwood (*Populus deltoides;* FAC) occurring as associates. Possibly the frequency and magnitude of flooding, with its scouring action and deposition, creates an environment that favors the establishment of hydrophytic vegetation or selects against nonhydrophytes.

Shrub Stratum

Results for the shrub stratum were similar to those for the tree stratum: generally good correlation between soil and shrubs, except the nonhydric Limerick soil.

Herb Stratum

Overall, the herb stratum showed only a fair correlation between vegetation and soil. The correlation was good for 15 of 20 sites, but at 5 sites, the weighted and index average means were either higher or lower than expected (Appendix C, Table C-3).

At two very poorly drained Saco soil sites (sites 14 and 15), the predominance of two UPL species (hay-scented fern and northern dewberry and the abundance of four FACU species (bracken fern [*Pteridium aquilinum*], wintergreen [*Gaultheria procumbens*], ground pine [*Lycopodium obscurum*], and wild sarsaparilla [*Aralia nudicaulis*]) gave these sites weighted averages of 3.96 and 3.75 and index averages of 3.89 and 4.00. These were the highest averages recorded for any hydric soil in the study.

The nonhydric Limerick soil again showed poor correlation between vegetation and soil. Sites 1 and 4 had weighted averages of 2.00 and index averages of 1.97 and 2.00. The low values were due to the prevalence of wood nettle (*Laportea canadensis*) and the abundance of two other FACW species, white grass (*Leersia virginica*) and ostrich fern (*Matteuccia struthiopteris*).

One of the two nonhydric Winooski soil sites (site 17) showed contrary results—good correlation between vegetation and soil using weighted averaging but poor correlation using index averaging (mean <3.0). This difference was attributed to the occurrence in three sample quadrats of an OBL species, skunk cabbage. This plant had less than 5% cover (cover class 1), so it did not significantly affect the weighted average value.

Combined Strata

When data from all strata were combined (Appendix C, Table C-4), there was generally good correlation between vegetation and soil, with two exceptions: the nonhydric Limerick soil (sites 1 and 4), which had weighted and index average means ≤2.00, and the hydric Saco soil on the mature floodplain in Whately (sites 14 and 15), where average means were about 3.00.

Hydric soils at 12 of 13 sites had weighted averages below 3.0, and one site (Saco, site 14) had a value of 3.0. Eleven of the hydric soil sites had index averages <3.0. Two Saco sites (sites 14 and 15) had index averages of 3.50 and 3.00.

Five of the seven nonhydric soils had weighted averages and index averages ≥3.0. The two exceptions were the nonhydric Limerick soils at sites 1 and 2 on the active floodplain in Northampton.

Hydrology

Hydrologic data for all sites are presented in Figs. 3–6. Data for Hadley soils and the Winooski soil at site 17 are not presented because the water tables were below 4 m throughout the study.

Soil saturation is probably more pronounced during average rainfall years; however, 1988 and early 1989 were characterized by drought conditions. After late March 1989, rainfall was higher than average, and water tables

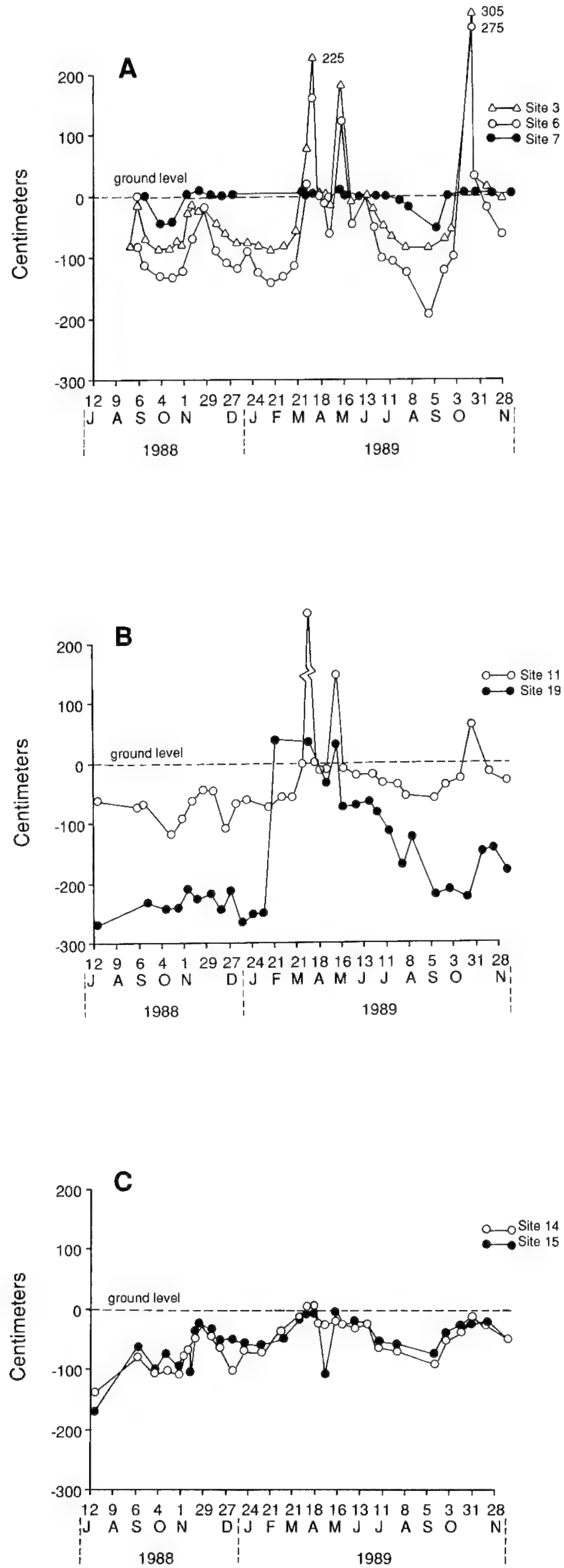

Fig. 3. Seasonal water table fluctuations in the Saco soils: A. Sites 3, 6, and 7; B. Sites 11 and 19; C. Sites 14 and 15.

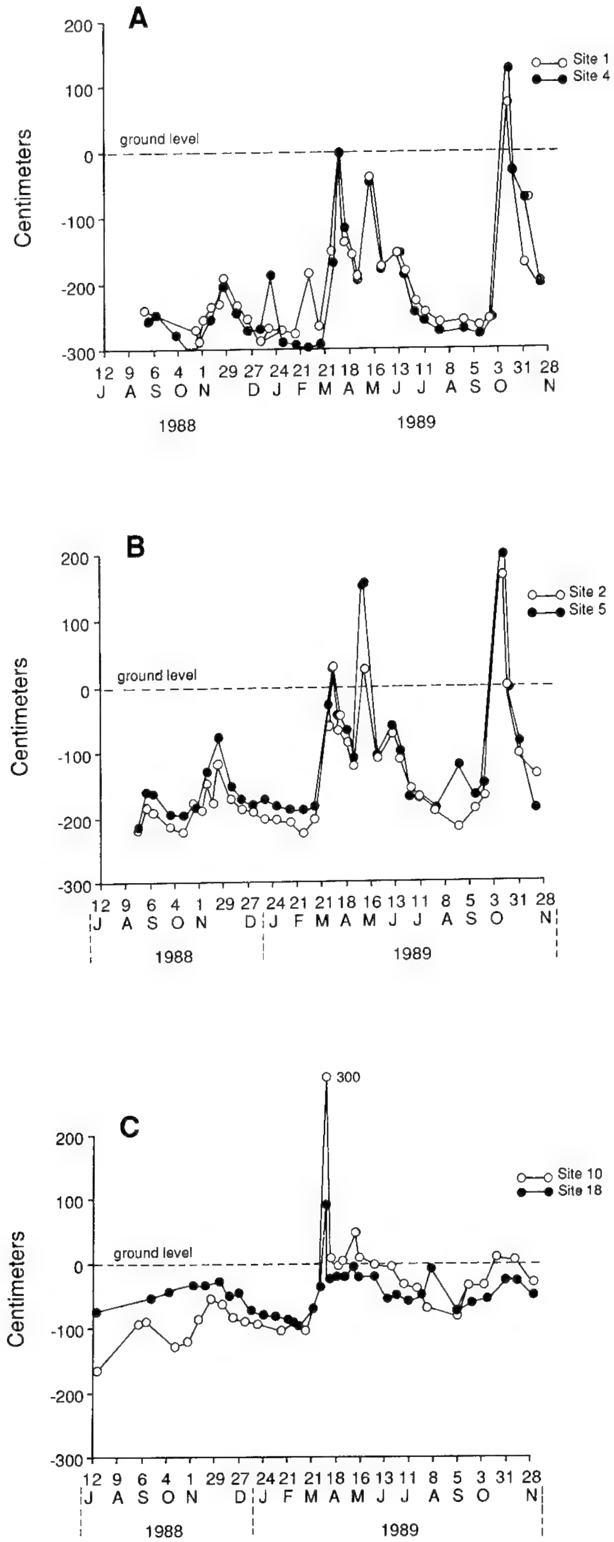

Fig. 4. Seasonal water table fluctuations in the Limerick soils: A. Sites 1 and 4 (nonhydric); B. Sites 4 and 5 (hydric); C. Sites 10 and 18 (hydric).

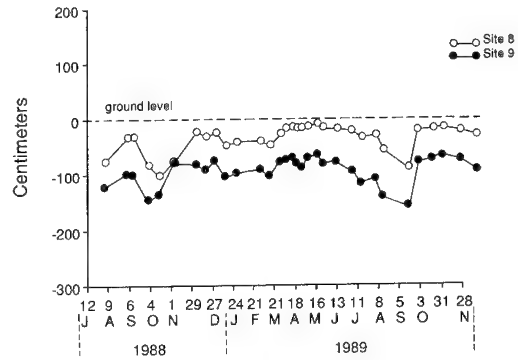

Fig. 5. Seasonal water table fluctuations in the Rippowam and the Pootatuck soils at sites 8 and 9.

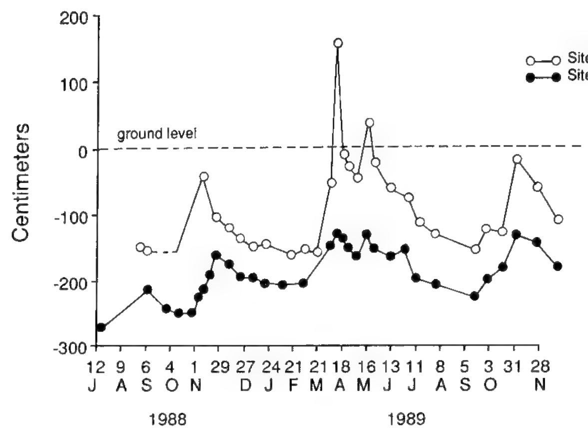

Fig. 6. Seasonal water table fluctuations in the Winooski soils at sites 12 and 13. (The Winooski soil at site 17 had a water table below 4 m throughout the study.)

were higher than average throughout the rest of the year (U.S. Geological Survey 1989).

The water table at Saco soil site 7 never dropped below 1 m, stayed within 50 cm of the soil surface for most of the year, and was at the soil surface for several months in spring (Fig. 3A). Conversely, the Saco soil at site 19 (Fig. 3B) had a water table at 2 m depth for most of the year, yet was flooded from February through May. This site was subject to fairly rapid fluctuation of the water table. The Saco soils at sites 14 and 15 were wet most of the year (Fig. 3C).

Water table levels in the Limerick soils (Fig. 4) were generally lower than in the Saco soils. Limerick soils on the higher floodplain landscape positions (sites 1 and 4) were flooded for less than a week at a time (Fig. 4A). Soils on the lower landscape positions (sites 2 and 5) had higher water table levels (but generally still below 1 m) with only

brief floodings (Fig. 4B), whereas Limerick soils on floodplains farther from the river (sites 10 and 18) were close to saturation for much longer.

Measurements in the Pootatuck soil (site 9) indicated water table levels around 1 m throughout the year, while the Rippowam soil (site 8) had a water table within 50 cm of the soil surface for most of the growing season (Fig. 5).

The Winooski soils at sites 12 and 17 were below 1.5 m for most of the year (Fig. 6), and site 8 had water table levels within 50 cm of the soil surface for a significant part of the growing season.

Discussion

Soils

Floodplains are largely dominated by mineral soils. Associated wetlands, therefore, are mainly composed of hydric mineral soils. These soils are defined as hydric on the basis of soil drainage classes, permeability rates, water table positions, and the duration of soil saturation, ponding, and flooding during the growing season (Table 1). Most hydric mineral soils, in response to forming in an anaerobic environment, develop characteristic gleying or mottling (Tiner and Veneman 1989). These soil morphological properties are useful and reliable field indicators of long-term wetness. Moreover, colors associated with these properties can usually be readily observed in the field.

The assessment of the hydric character of Connecticut River floodplain soils was complicated by low chroma colors inherited from the parent material. Most of the C-horizons had chromas of 2 or 3 not necessarily due to wetness (see Appendix B). Flooding frequently deposited new materials or eroded the soil. Consequently, the soils—especially in the active floodplain—did not show significant profile development—that is, no B-horizon. Redox processes generally seemed slow; only under optimum conditions were changes in soil morphology evident. In the very poorly drained Saco series, the environment (i.e., prolonged soil saturation, high organic matter content, and soil temperatures above biological zero or 4° C for the majority of the year) was seemingly conducive to rapid reduction and oxidation. Formation of prominent high and low chroma mottles was evident 3 years after deposition of the parent material by the severe 1985 flood.

In the slightly better drained soils (e.g., Limerick soils, sites 1 and 4), organic matter accumulation was slow, frequency and duration of flooding was lower, and morphological changes were less visible than in similar non-floodplain soils. The Limerick soils (sites 1 and 4) occurred on fingerlike ridges running somewhat parallel to the river. During the initial site selection, these soils were considered Winooski series. However, careful field examination reflected by detailed profile descriptions (Appendix A) revealed the presence of some faint 2.5Y 4/4 mottles and a dominant color of 2.5Y 4/2 within 45 cm. These soils appeared to be hydric, based on the presence of certain field indicators. The soils, however, were flooded for only a few days in October 1989 (an average flooding year) and remained unsaturated immediately after flooding; hence, they were aerated, as demonstrated by the drastic drop of the water table on recession of the flood (Fig. 4A). These soils had predominantly silt loam textures, resulting in fairly low permeabilities. Normally, we would not expect them to drain rapidly, yet bubbles were observed during flooding events, indicating the escape of large amounts of entrapped air from unsaturated soils. Consequently, these soils probably were not anaerobic for any significant time. These soils were considered non-hydric because of the weak mottling, the faintness of the contrast (mottle vs. matrix), the landscape position (ridges), the somewhat poorly drained nature of these soils, and the hydrology of these sites.

In the very poorly drained Saco soils, flooding lasted long enough to release most or all of the entrapped air, causing pronounced anaerobic conditions, thereby qualifying these soils as hydric soils (sites 3 and 11 in Figs. 3A and 3B). Moreover, soil morphological properties supported the hydric designation—for example, low chroma matrix with high chroma mottles (Tiner and Veneman 1989).

Poorly and very poorly drained soils were hydric, but the well-drained floodplain soils (Hadley series) always fell outside the range of hydric soil characteristics (Fig. 7). Poorly drained members of the Limerick series were hy-

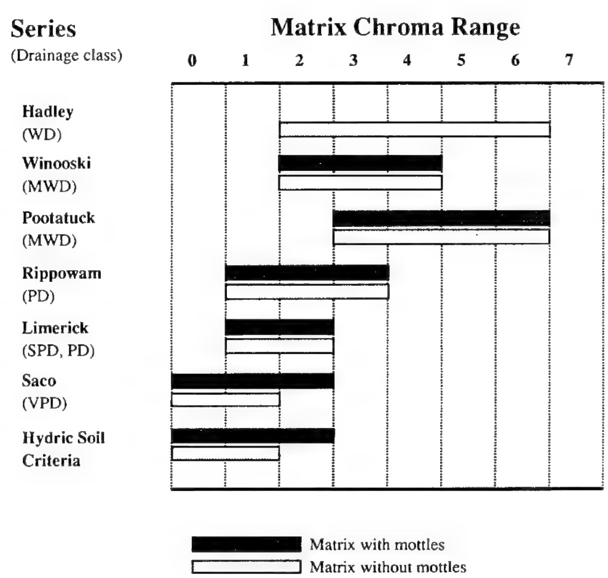

Fig. 7. Range of dominant chroma values permitted within 45 cm of the soil surface in the soil series studied, compared with applicable hydric soil criteria.

dric, whereas the somewhat poorly drained members may or may not be hydric.

The moderately well-drained Winooski series may be hydric under certain conditions. The Winooski series description (Appendix B) includes a matrix chroma range of 2 through 4 and requires the presence of low chroma mottles at depths 35–50 cm. So, a Winooski soil with a dominant matrix chroma of 2 and brighter mottles and within 45 cm may have field indicators for hydric soil. However, this soil must still be considered moderately well-drained due to Soil Conservation Service-designated series criteria. Such soils may meet hydric soil criterion #4 (see Table 1). The Winooski soil at site 12 illustrates this situation (Fig. 6). It was flooded for more than 1 week on two occasions during our study and had a seasonal high water table in 1989. This soil had wetland hydrology and supported hydrophytic vegetation (Appendix C). The Winooski series needs to be redefined to exclude mottling within the upper 45 cm. If this were done, the soil at site 12 would be a somewhat poorly drained Limerick series, which is on the national list of hydric soils.

Vegetation

Species Richness

We found that soils located on the mature floodplains that were infrequently flooded supported more species than soils located on the active floodplain, which were subject to much scouring and deposition. This agrees with the observations of Bell (1980), who found highest species richness in areas of rare flooding and lowest in areas of severe flooding.

Correlation Between Hydrophytic Vegetation and Hydric Soil

In general, there was good agreement between hydrophytic vegetation, as defined in this study (i.e., weighted or index average value <3.0), and hydric soil, especially when data from all strata were combined. Two of the seven hydric Saco sites (sites 14 and 15), however, had average values at or slightly above 3.0, with the rest having values around 2.0. These sites were located in Whately on the mature floodplain along an unnamed intermittent stream that empties into Great Pond in Hatfield. These areas were not subject to the heavy scouring action and deposition characteristic of wetlands along the mainstem of the Connecticut River. The herb stratum appeared "drier" because of the abundance of UPL and FACU species. The two UPL species were hay-scented fern and northern dewberry. Given the abundance of these species, it may be that their wetland indicator status should be FACU– rather than UPL. If this were the case, the weighted and index averages would have been <3.0. The soils were obviously hydric at these two sites.

Hydrophytic vegetation was also present on two nonhydric Limerick soils (sites 1 and 4) on the active floodplain of the main stem of the Connecticut River. These soils are flooded each year, perhaps a few times, for brief periods (<1 week). They do not appear to be anaerobic even after a few days of flooding, as demonstrated by the release of air bubbles from flooded soils. Although flooded annually, these soils were not flooded long enough to be hydric. The frequency of flooding, scouring, and deposition seems to be responsible for the establishment of hydrophytic vegetation. The herb stratum was dominated by wood nettle and ostrich fern, both listed as FACW species. These species may, perhaps, be better considered FAC species, based on our observations here and in other floodplains, as well as those of Ken Metzler (personal communication). Metzler and Damman (1985) found ostrich fern on the highest ridges of the inner floodplain of the Connecticut River near Hartford, Connecticut. If the indicator status of these two species were changed to FAC, the weighted and index averages would change somewhat but would still be <3.0. The vegetation would still be considered hydrophytic, but the averages would probably be >2.5. Thus, averages would fall within the 2.5–3.5 range, where Wentworth and Johnson (1986) recommended that soils and hydrology be examined to make a wetland determination because vegetation data alone are inadequate for making a decision (see section "The 3.0 Breakpoint"). Further studies are needed concerning the indicator status of these two species—studies to determine if a change in status is warranted or whether our observations represent a localized condition.

Weighted Averages versus Index Averages

In general, weighted averages and index averages provided similar results for vegetation at hydric and nonhydric sites. On one nonhydric Winooski soil (site 17), however, the index average for the herb stratum fell below 3.0 because of the occurrence of a few single plants of skunk cabbage, an OBL species, in two of the five plots. In our opinion, this species is correctly designated as OBL; however, the noted occurrence demonstrates that on rare occasions such species can be found in nonwetlands. The index average approach would characterize the herb stratum as hydrophytic in this study, whereas the weighted average method did not identify hydrophytic vegetation. The weighted average adjusted the presence of skunk cabbage by its relative abundance (i.e., <5% cover). When data from all strata were combined for this site, however, the weighted average (3.38) and index average (3.39) values were essentially equal. Hence, overall, the two averages were not different. We feel, however, that the weighted average provides more consistent and reliable

results for all strata than the index average, and we recommend its use over the index average method.

Comparison of Sampling Techniques for the Herb Stratum

We collected data for the herb stratum in two ways—by visually estimating percent cover and by counting stems (density). These two data sets did not show any significant difference between weighted and index average values (Table 9). Therefore, we recommend that cover estimates be employed rather than the more labor-intensive stem counts.

Sample Plot Size

In the active floodplain at Rainbow Beach in Northampton, Massachusetts, the trees were large and widely spaced. The 100-m^2 plot sample often did not include any trees, despite nearly total crown closure. Similar results were obtained in a soil–vegetation study along the Carson River in Nevada, where widely spaced cottonwoods and willows were undersampled (Nachlinger 1988). Although the plot size was not changed for our study, we recommend that, in such cases, the plot size be expanded to include at least two trees for measuring dbh. It may even be better to use a plotless method, where an angle gauge or a basal area factor prism is used to calculate basal area. Alternatively, visual estimates of canopy cover may be the most efficient means of evaluating the tree stratum for wetland determinations. This works best when the tree stratum is low in diversity. The higher the diversity, the more important it is to measure dbh to determine vegetative composition or dominant species.

Separation of Shrub Stratum from Tree Stratum

Using dbh to separate trees from shrubs worked fairly well. However, many woody plants had dbh values around the breakpoint of 7.5 cm, which required many additional dbh measurements. This was particularly true for saplings of tree species. If a height limit had been established (e.g., 20 feet), it would have further reduced the effort required to measure dbh. This can be especially useful when shrub dominance is measured by density or by estimating areal cover.

The 3.0 Breakpoint

The 3.0 value represents a useful breakpoint for separating hydrophytic vegetation from nonhydrophytic vegetation. However, it is not without exceptions or problems. In this study, we found "hydrophytic" vegetation on nonhydric soils (Limerick, sites 1 and 4) and "nonhydrophytic" vegetation on hydric soils (Saco, sites 14 and 15). In these cases, the nonhydric Limerick soils had the lowest averages recorded at any of the sites; when all strata were

Table 9. *Comparison of weighted averages and index averages for the herb stratum derived from cover estimates and stem density counts.*

Soil type (drainage class[a])	Site	Weighted average mean: Cover estimates	Weighted average mean: Stem counts	Index average mean: Cover estimates	Index average mean: Stem counts
Saco*[b] (VPD)	3	1.80	1.82	1.92	1.91
	6	2.00	2.00	2.00	2.00
	7	1.95	1.91	1.87	1.88
	11	2.06	2.07	2.14	2.14
	14	3.68	4.27	4.19	4.35
	15	3.80	4.21	3.94	3.94
	19	1.89	1.94	2.00	1.89
Limerick* (SPD, PD)	2	2.00	2.00	2.00	2.00
	5	2.00	2.00	2.03	2.00
	10	2.01	2.03	2.08	2.08
	18	2.01	1.95	1.97	1.98
Rippowam* (PD)	8	2.06	2.00	2.16	2.27
Winooski* (MWD)	12	2.03	2.17	2.22	2.26
Limerick (SPD)	1	2.00	2.00	1.98	2.01
	4	2.00	2.00	2.00	2.00
Winooski (MWD)	13	3.99	3.97	3.97	3.95
	17	3.10	3.20	3.01	3.13
Pootatuck (MWD)	9	3.01	3.06	3.03	3.14
Hadley (WD)	16	3.43	3.19	3.49	3.40
	20	3.70	3.84	3.64	3.63

[a]* = hydric soil.

[b]Drainage classes: VPD = very poorly drained; PD = poorly drained; SPD = somewhat poorly drained; MWD = moderately well-drained; WD = well-drained.

combined, weighted and index averages ranged from 1.97 to 2.03. The Saco soils at sites 14 and 15 had averages around 3.0, ranging from 2.96 for weighted average (site 15) to 3.05 for index average (site 14).

Although the 3.0 breakpoint is useful for separating hydrophytic from nonhydrophytic vegetation, it cannot be viewed as definitive. Some wetlands clearly have values >3.0, and some nonwetlands have averages <3.0. Therefore, any methodology designed to identify vegetated wetlands by vegetation criteria alone must recognize this fact. It is prudent to examine the soils for hydric properties and look for indicators of wetland hydrology when the value is ≥2.0 and ≤4.0 for undisturbed, natural sites. Our conclusions agree with observations by Wentworth and Johnson (1986; as illustrated in Fig. 8) and with the recommended methods in the new manual, Federal Interagency Committee for Wetland Delineation (1989).

Hydrology

Hydrologic forces create, shape, and maintain wetlands. The presence of "excess" water for a significant period makes a given area "wet" land. Prolonged soil saturation and permanent or periodic inundation are indicative of wetland hydrology. The leading Federal agencies in wetland regulation and conservation have specifically defined wetland hydrology to include many areas that have a seasonally high water table within 45 cm of the soil surface or that are usually inundated (flooded or ponded) for a week or more during the growing season (Federal Interagency Committee for Wetland Delineation 1989). These hydrologic conditions normally create an anaerobic environment that favors the establishment of hydrophytic vegetation and the formation of typical hydric soil properties (e.g., gleying and mottling).

Although wetland hydrology is the essence of all wetlands, it is a dynamic feature that varies daily, seasonally, and annually, as demonstrated by water table fluctuations (Figs. 3–6). Because of this inherent variability, wetland hydrology is not readily identifiable throughout the year, and wetlands are usually identified by certain plant communities and soils that are the manifestations of wetland hydrology. Hydric soils are widely viewed as reliable indicators of long-term hydrology, whereas hydrophytic vegetation is often considered more responsive to short-term hydrologic conditions. Remember, however, that when empirical data show that an area is inundated or saturated long enough and often enough during the growing season to possess wetland hydrology, the area should be wetland—in a general sense, at least. (All too often, careless researchers may forget about hydrology and consider only

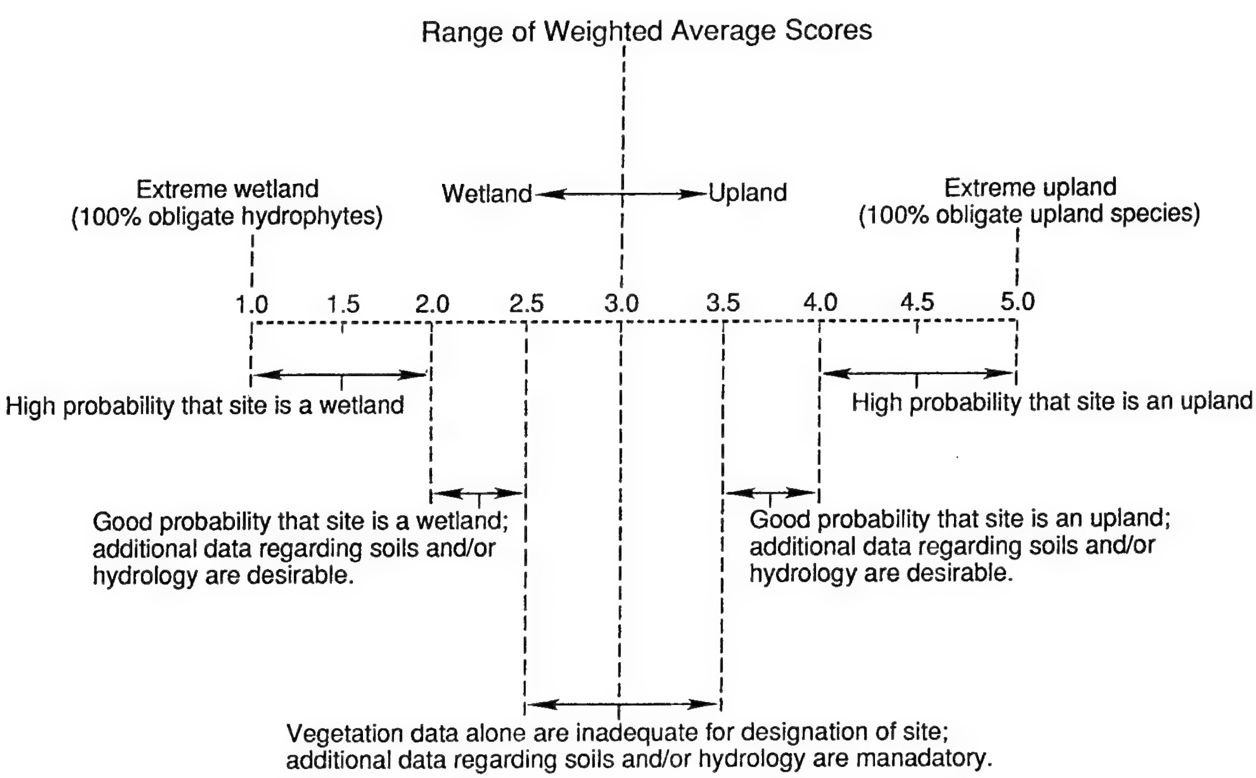

Fig. 8. Recommended application of weighted and index averages for wetland identification. Varying degrees of confidence should be assigned to wetland or upland designation based on weighted or index average scores; scores that are farther from the theoretical wetland–upland boundary of 3.0 are considered to be better indicators of wetland or upland status (Wentworth and Johnson 1986.)

the vegetation or the soils in determining whether or not an area is wetland.)

The Connecticut River is a spring-flooding river, with peak discharge in April following snowmelt in New Hampshire, Vermont, and Canada (Fig. 2). Hurricanes and tropical storms may cause severe flooding at other times. At the start of our study, we observed evidence of recent flooding on the Rainbow Beach floodplain in Northampton: Debris was found in silver maples, and silt lines were found on cottonwoods and maples, sometimes at levels >3 m above ground level (Fig. 9).

Metzler and Damman (1985) reported that the frequency, duration, and timing of flooding are the major factors controlling vegetation patterns in the low floodplain of the Connecticut River around Hartford. While elevation above the river is important in affecting flooding frequency, it is not solely responsible for the vegetation patterns—isolated depressions or periodically connected sloughs at high elevations may be inundated for much longer periods than better-drained, lower areas that are openly connected to the river (Robertson et al. 1978; Buchholz 1981; Metzler and Damman 1985). Once these depressions are flooded, surface water and saturated soils persist until water is removed by evapotranspiration and percolation. Natural drainage patterns, therefore, become important in assessing site inundation and soil aeration on floodplains.

Conclusions

The following are the conclusions reached in this study.

1. In general, hydric soils in the Connecticut River floodplain of western Massachusetts supported hydrophytic vegetation, whereas nonhydric soils did not.
2. The weighted average method was preferred over the index average method because the latter may be unduly influenced by an atypical occurrence of a single species.
3. The 3.0 weighted or index average value was generally a useful breakpoint for separating hydrophytic vegetation from nonhydrophytic vegetation, but it should not be considered definitive, as there were exceptions.
4. Active (young) floodplains—including wetlands subject to flooding for long duration (usually one week or more) and nonwetlands subject to brief annual flooding—all supported hydrophytic vegetation as defined here.
5. Mature floodplains had higher species richness than young or immature floodplains.
6. The regional wetland indicator status should be reevaluated for *Laportea canadensis*, *Matteuccia struthiopteris*, *Dennstaedtia punctilobula*, and *Rubus flagellaris*.
7. Soils at higher positions on the floodplain usually were flooded for periods less than a week; these soils did not appear to be anaerobic, as indicated by escaping air bubbles observed during flooding and by the rapid fall of the water table after inundation.
8. Soils on the lower floodplain were saturated for long periods, sometimes exceeding 2–3 months during spring and early summer. They had typical hydric soil morphological properties (gleying and mottling) and hydrophytic vegetation.
9. The range in morphological characteristics for some floodplain soil series (e.g., Limerick and Winooski) needs to be better defined to effectively separate hydric from nonhydric soils.
10. Soil morphological properties were useful indicators of the hydrology of soils on the Connecticut River floodplain.
11. Future soil–vegetation correlation studies should include hydrologic observations to assist in the interpretation of research results.

Acknowledgments

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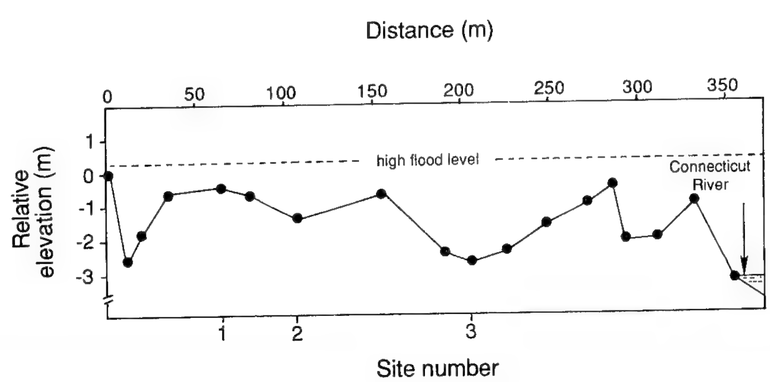

Fig. 9. Transect through Rainbow Beach, Northampton, Massachusetts, showing relative elevation levels. High flood level was determined from silt lines on tree trunks.

Collins, Colorado, performed the statistical analysis. J. Bartos, S. Bodine, and M. Reed prepared soil profile descriptions and assessed the variability of soils within the vegetation plots. C. Chase-Dunn provided the water table measurements of the sites. J. Gookin helped verify statistical data. The draft manuscript was reviewed by F. Golet (University of Rhode Island), K. Metzler (Connecticut Department of Environmental Protection), M. Scott and C. Segelquist (Fish and Wildlife Service), W. Sipple (Environmental Protection Agency), and W. Slauson (TGS Technology, Inc.). The U.S. Geological Survey provided Turners Falls Dam discharge data.

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Appendix A. Soil Profile Descriptions for Study Sites Arranged by Soil Type and Hydric Status

SACO silt loam
Site: 3
Taxonomic Class: Typic Fluvaquent, coarse-silty, mixed, nonacid, mesic
Hydric Status: Hydric
Date Described: 5 November 1986
Location: Rainbow Beach, Northampton, Hampshire County, Massachusetts

Horizon	Depth (cm)	Description
01	0–4	Dark olive gray (5Y 3/2) silt loam stratum forms a base (2 cm thick) of horizon with an olive (5Y 5/3) very fine sand surface, which is built up to give the horizon a thickness of 15 cm in places; silt loam is massive and friable, and very fine sand has weak fine platy structure and very friable; silt loam has 5% fine tubular and irregular prominent clear brown and strong brown (7.5YR 4/4 and 5/8) ferrans around pores; very fine sand is complexly mottled with 10% fine and medium faint clear olive brown (2.5Y 4/4), 10% coarse faint diffuse olive gray (5Y 4/2) mottles and 10% combined dark gray (5Y 4/1) neoalbans and yellowish-brown (10YR 5/6) quasiferrans surrounding the few rooting pores and krotovinas; medium and coarse irregular pores; few very fine, fine, and medium roots; few medium krotovinas with dark grayish-brown (2.5Y 3/2) fine granular fillings; boundary between silt loam and very fine sand has a dark reddish brown (5YR 2.5/2) fibric layer (1 mm thick); abrupt smooth boundary
02	4–23	Dark olive gray (5Y 3/2) silt loam with large vertical planar voids coated with prominent thick dark reddish-brown (2.5YR 3/4) ferrans; weak fine and medium subangular blocky structure; friable; large vertically oriented planar voids and common fine and medium irregular voids; few very fine, fine, and medium roots; few medium and coarse ferran coated fine granule filled krotovinas; common rotting sticks throughout; clear smooth boundary
03	23–34	Dark olive gray (5Y 3/2) silt loam becoming dark gray (5Y 4/1) and slightly finer in lower 3 cm, with 30% (upper part) to 15% (lower part) of exposed surface having mostly dark reddish-brown (2.5YR 2.5/4 and 5YR 3/4) ferrans on voids and pores with minor brown (7.5YR 4/4) ferrans on walls of coarse tubular earthworm channels; moderate fine and medium subangular blocky structure; friable (slightly sticky and slightly plastic); common large poorly oriented high chroma ferran coated planar voids, several of which, however, extend vertically from this horizon to the soil surface; few roots of all grades; common medium and coarse, fine, and medium ferran coated granule filled, irregular krotovinas (color of which parallel those of void and pore ferrans); abrupt smooth boundary (somewhat arbitrarily chosen based on a pattern repeated in horizon 04; horizons 03 and 04 each have a zone (2–5 cm and 5–7 cm, respectively) of intense ferran development at the top of the horizon, the lower part much less so)
04	34–58	Colors very similar to horizon 03, except that dark reddish brown (5YR 3/4) more prominent here, dark olive gray (5Y 3/2) silt loam becoming dark gray (5Y 4/1) in lower part, with 30% (upper part) to 15% (lower part) of exposed surface having mostly medium and coarse prominent thick mostly dark reddish-brown (5YR 3/4 and 2.5YR 2.5/4) ferrans on generally unoriented voids and pores and minor brown (7.5YR 4/4) ferrans on walls of coarse tubular earthworm channels; moderate fine and medium subangular blocky structure becoming weak coarse subangular blocky to massive with depth; friable

		(slightly sticky and slightly plastic); common large unoriented planar voids; few tubular pores of all grades and few fine and many to common with depth medium and coarse irregular pores; few roots of all grades; lower part has common layers of leafy debris; clear smooth boundary
05	58–76	Mixed dark greenish-gray (5GY 4/1) and dark dark gray (5Y 4/1) loamy very fine sand–very fine sandy loam matrix with 15% medium and coarse prominent dark red (2.5YR 3/6) ferrans with clear olive brown (2.5Y 4/5) quasiferrans bleeding into matrix along worm channels and ephemeral rooting pores; base of horizon is characterized by a sapric olive gray (5Y 4/2) mat; massive; nonsticky, nonplastic; few tubular pores of all grades; few very fine and fine roots; abrupt smooth boundary
06	76–127+	The following sub-horizons can be distinguished: (a) dark greenish-gray (5GY 4/1) fine sand to 86 cm, (b) hemic, dark brown (10YR 3/3) leaf mat 86–88 cm, (c) dark greenish-gray (5GY 3/1) coarse silt loam 88–102 cm (d) dark greenish-gray (5GY 4/1) fine sand 102–127+ cm; no mottles; single grain to massive with finer texture; nonsticky, nonplastic; few very fine roots in upper part

SACO silt loam
Site: 6
Taxonomic Class: Typic Fluvaquent, coarse-silty, mixed, nonacid, mesic
Hydric Status: Hydric
Date Described: 2 November 1986
Location: Rainbow Beach, Northampton, Hampshire County, Massachusetts

Horizon	Depth (cm)	Description
01	0–15	Complex horizon divided for description into three zones: (a) 0–2 cm, very dark grayish-brown (2.5Y 3/2) silt loam, generally mottle free (b) 2–4 cm, olive gray (5Y 4/2) finely stratified very fine sands and silt loams with medium prominent diffuse strong brown (7.5YR 5/8) and dark yellowish-brown (10YR 4/6) neoferrans that bleed through olive brown (2.5Y 4/4) to the matrix color around pores and channels; moderate fine and medium subangular blocky structure with granulated interpeds in upper part becoming weak medium and coarse subangular blocky with depth; friable; few very fine and medium roots; common tubular pores of all sizes, common very fine, fine, and medium irregular pores, some associated with earthworm channel fillings, others lentil-shaped; clear smooth boundary (c) 4–15 cm, olive gray (5Y 4/2) to dark olive gray (5Y 3/2) silt loam matrix (70%) with 10–15% of granulated interpeds coated dusky red (2.5YR 3/2), and 15–20% fine and medium prominent clear and sharp ferrans on pore walls
02	15–33	Complex horizon divided for description into three zones: (a) 15–20 cm, olive gray (5Y 4/2) silt loam matrix with many fine and medium prominent clear and sharp dark reddish-brown (5YR 3/4) and strong brown (7.5YR 4/6) ferrans on lentil shaped pore walls that often have a dark reddish-brown (5YR 3/3 and 2.5/2) mottled border zone with matrix; fine and medium subangular blocky structure; friable; common tubular pores of all size grades; few very fine, fine, and common large irregular pores within earthworm channel fillings; common fine and medium irregular lentil shaped pores; and few medium and large spherical voids; few very fine granules partially fill large pores, otherwise granular fillings are dark brown (10YR 3/3), fine, and medium in size (some with higher chroma ferrans) (b) 20–27 cm, much like horizon 01 but shows fewer effects of earthworm activity and separated from horizon 02(c) by a 1-cm olive gray (5Y 4/2) layer with few mottles (c) similar to horizon 02(a) but lentil-shaped pore structure is better developed; gradual smooth boundary

03	33–55	Olive gray (5Y 4/2) silt loam matrix with 20% of surfaces (on average) coated with fine and medium irregular prominent sharp reddish-brown (5YR 4/4) and brown (7.5YR 4/4) ferrans on incomplete ped faces; large tubular pores commonly lined brown (10YR 4/3), 38–43 cm becoming very dusky red (2.5YR 2.5/2); moderate fine and medium subangular blocky structure; friable; few roots of all grades; common very fine and fine tubular root pores, and common medium and few coarse tubular pores; many medium and common large irregular pores resulting from earthworm activity; clear smooth boundary
04	55–62	Dark gray (5Y 4/1) and olive gray (5Y 4/2) very fine sandy loam–coarse silt loam matrix with 25–30% distinct clear olive brown (2.5Y 4/4) mottles often with dark reddish-brown (2.5YR 3/4) cores; weak medium and coarse subangular blocky structure; friable; few roots of all grades; common very fine and fine tubular rooting pores, and common medium tubular pores; many irregular pores of varying origin; few medium tubular and irregular earthworm channel fillings; clear smooth boundary
05	62–86	Complex horizon divided for description into 5 zones: (a) 62–66 cm, olive gray (5Y 4/2) silt loam with 15% fine through coarse irregular prominent clear and sharp strong brown (7.5YR 4/6) ferrans on weakly expressed fine and medium subangular blocky ped faces and some rooting pores; friable; few roots of all grades; many fine, common very fine, and few medium and coarse tubular pores; few fine, medium, and coarse irregular pores; few medium and large fine granule filled earthworm channels (b) 66–73 cm, olive gray (5Y 4/2) coarse silt loam, with fine through coarse irregular prominent clear and sharp dark red (2.5YR 3/6) neoferrans coating 30–40% of the moderate fine and medium subangular blocky ped surfaces; friable; few roots of all grades; common very fine and fine and few medium and coarse tubular pores; many medium and few fine and coarse irregular interpedal pores; few medium and large fine granule filled earthworm channels (c) 73–76 cm, very similar to horizon 05(a) (d) 76–82 cm, very similar to horizon 05(b) except that ferrans are nearly all very dusky red (2.5YR 2.5/2) and structure is subangular blocky with well expressed, predominantly horizontally oriented, lentil-shaped interpeds making up about half of the ped surfaces (e) 82–86 cm, very similar to horizons 05(a) and 05(d) but ferrans on vertical faces are commonly dark reddish brown (5YR 2.5/2) and dark red (2.5YR 3/6); clear smooth boundary
06	86–102	Olive gray (5Y 4/2) micaceous very fine sandy loam–loamy very fine sand with 30% coarse irregular faint diffuse olive (5Y 4/3) mottles throughout, and 5–10% variable distinct and prominent clear olive brown (2.5Y 4/4) and strong brown (7.5YR 4/6) ferrans around rooting pores, 2% medium and coarse irregular prominent and sharp dark red (2.5YR 3/6) ferrans on some pore walls; massive; nonsticky, nonplastic; few very fine and fine roots; few very fine and fine tubular pores; clear smooth boundary
07	102–122	Two sequences of about equal thickness of very dark gray (5Y 3/1) silt loam over gray (5Y 4/1) loamy very fine sand, each with 15% coarse irregular prominent clear to yellowish-red (5YR 4/6) neoferrans around rooting pores and in coarse strata these bleed to olive brown (2.5Y 4/4); massive; nonsticky, nonplastic; few very fine and fine roots; few very fine and fine tubular pores; abrupt smooth boundary
08	122–142	Coarsely stratified gray (5Y 4/1) sand and fine sand with scattered dark gray (N 4/) strata, from which few coarse distinct diffuse olive brown (2.5Y 4/4) neoferrans bleed into matrix, 1% 8–10 cm-thick prominent clear tubular yellowish-red (5YR 5/8) mottles present in upper part; single grained; nonsticky, nonplastic; few very fine and fine roots (possibly dead); accumulation of hemic through sapric (rubbed) material at 132–137 cm

SACO silt loam
Site: 7
Taxonomic Class: Fluvaquentic Humaquept, coarse-silty, mixed, nonacid, mesic
Hydric Status: Hydric
Date Described: 17 August 1988
Location: West Hatfield, Hampshire County, Massachusetts

Horizon	Depth (cm)	Description
Oi/Oe	12–0	Very dark grayish brown (10YR 3/2); thick root mat; clear wavy boundary (7–17 cm thick)
A	0–27	Very dark grayish-brown (2.5Y 3/2) silt loam with common (15%) medium irregular olive brown (2.5Y 4/4) mottles in zones covering 40% of exposed surface; weak to moderate fine subangular blocky structure; very friable; many very fine and common fine roots with 2% fine and medium decayed roots; few (0.1%) very fine tubular pores; few fine perforations on slightly lustrous ped faces, many thin red (2.5YR 4/8) channel ferrans on fine roots fading (within 2 mm) to reddish-yellow (7.5YR 6/8) neoferrans occurring in zones with mottles, common thin dark reddish-brown (2.5YR 3/4) channel ferrans and common to many thin dark reddish-brown (2.5YR 3/4) ped coatings occuring in 70% of exposed surface; very few coarse decayed roots still firm at top of horizon; diffuse wavy boundary (25–29 cm thick)
AC	27–38	Dark grayish brown (2.5Y 4/2) silt loam with common medium distinct irregular clear very dark gray (10YR 3/1) and few medium irregular grayish-brown (2.5Y 5/2) mottles in zones covering 30% of exposed surface; weak fine to medium subangular blocky structure; very friable; common very fine and fine roots with 1% fine and medium decayed roots; few (0.1%) very fine pores; many thin yellowish-red (5YR 4/6) ped coatings in zones (30% of exposed surface) along with channel ferrans mentioned for A horizon; clear wavy boundary (9–13 cm thick)
C1	38–61	Dark gray (5Y 4/1) silt loam with few fine to medium prominent irregular clear yellow (2.5Y 7/8) mottles; weak fine subangular blocky to fine platy structure; firm; common very fine roots decreasing in amount with depth and 2% medium to coarse decayed roots; few (0.1%) very fine pores; many continuous fine to medium, moderately thick strong brown (7.5YR 4/6) channel ferrans throughout horizon except for 60% of exposed surface of the layer (50–60 cm) where channel ferrans occur with reddish-yellow (7.5YR 7/8) neoferrans (2–3 cm diameter) covering 50% of exposed surface; 1% wood fragments (decayed roots and wood); clear wavy boundary (21–25 cm thick)
C2g	61–80	Dark gray (N 4/) silt loam with few fine horizontal banded very dark gray (10YR 3/1) mottles; weak fine platy structure; firm; common very fine roots and 3% fine to coarse roots both decayed and fresh appearing; few black (5Y 2.5/1) neoorgans (1 cm diameter) on fine root channels; few (1%) large (4–5 cm diameter) chunks of wood; clear wavy boundary (9–19 cm thick)
2Cg	80–90	Very dark gray (5Y 3/1) fine sandy loam with few banded mottles as above; massive to weak medium platy structure; friable; common to very fine roots and 2% decayed roots of all sizes; 3% decayed wood fragments; clear wavy boundary (7–13 cm thick)
3C	90–114+	Very dark gray (5Y 3/1) gravelly sand with finer sand mixed into top 5 cm of horizon; unconsolidated; 15–20% wood fragments of 2–5 cm diameter, with a few large logs (10 cm diameter), all appear fresh in place but easily break apart when disturbed (>24 cm thick)

SACO fine sandy loam, variant
Site: 11
Taxonomic Class: Fluvaquentic Humaquept, coarse-silty, mixed, nonacid, mesic
Hydric Status: Hydric
Date Described: 2 September 1987
Hydric Status: Hydric
Location: Manhan Meadows—West, Northampton, Hampshire County, Massachusetts

Horizon	Depth (cm)	Description
Oi	1–0	Matted leaf litter coating partially decomposed litter, fibrous and full of fine roots; abrupt smooth boundary
A	0–2	Very dark brown (10YR 2/2) silt loam; moderate very fine to granular structure; very friable; many very fine roots; clear smooth boundary
C1	2–10	Codominant dark grayish-brown (2.5Y 4/2) and gray (5Y 5/1) silt loam; common (20%) medium to coarse distinct brown (7.5YR 4/4) stains on ped faces and common (2–3%) fine prominent red (2.5YR 4/8) mottles; weak to moderate medium subangular blocky structure; friable; many very fine to coarse (≤15 mm) roots; clear wavy boundary
C2	10–40	Codominant dark grayish-brown (2.5Y 4/2) and gray (5Y 5/1) silt loam; common (5% each) medium faint gray (N 5/) and fine to medium clear yellowish-red (5YR 4/6) mottles, some of which occur together as channel neoalban–quasiferrans about fine to medium pores, also found are 5YR 4/6 channel ferrans, often coating very fine to fine pores; weak medium to coarse subangular blocky structure; friable to firm; many very fine to medium pores; many very fine to medium and common (decreasing with depth) coarse roots; clear wavy boundary
C3	40–53	Dark grayish-brown (2.5Y 4/2), with a slightly lesser amount of gray (5Y 5/1), fine sandy loam, with the top half of the horizon marked by numerous 5 × 20–30 mm lenses (or disturbed bands) of medium to coarse sand; few to common (2%) fine distinct strong brown (7.5YR 4/6) blotches and few (1%) fine prominent yellowish-red (5YR 5/8) mottles, common yellowish-red (5YR 4/6) channel ferrans are also present; massive; very friable; common very fine to medium (0.75–3.0 mm) pores; common very fine to fine, and few to medium to coarse roots; gradual wavy boundary
C4	53–88	Gray (2.5Y 5/1) fine sandy loam, with common large lenses of medium sand, lightly iron-stained, interspersed throughout; prominent strong brown (7.5YR 5/8) channel neoferrans occur about most pores, many dark red (2.5YR 3/6) channel ferrans and few fine prominent yellowish-brown (5YR 5/8) mottles also occur; massive; very friable; few to common very fine to fine and few medium pores; few to common very fine to fine roots; abrupt wavy boundary marked by a 4- to 5-mm band of iron-stained medium sand
C5	88–120+	Dark gray to gray (5Y 4-5/1, grading to 5Y 4-5/0 with depth) silt loam; many red to yellowish-red (2.5-5YR 4/6-8) channel ferrans and yellowish-red (5YR 5/7) channel neoferrans; weak medium to coarse subangular blocky structure; friable; common (6/cm^2) very fine to fine pores; few very fine to fine roots, in various stages of decay

SACO mucky silt loam
Site: 14
Taxonomic Class: Fluvaquentic Humaquept, coarse-silty, mixed, nonacid, mesic
Hydric Status: Hydric
Date Described: 5 November 1987
Location: Pilgrim Airport, Whately, Franklin County, Massachusetts

Horizon	Depth (cm)	Description
Oi	5–0	Fallen litter dominated by red oak and red maple leaves; clear wavy boundary
Oe	0–6	Matted moderately humified layer of very dusky red (2.5YR 2.5/2) decaying leaves; many very fine, common fine, medium, and coarse roots; clear wavy boundary
Oa	6–10	Dark reddish-brown (5YR 2.5/2) humus; common roots of all grades; clear wavy boundary
A	10–20	Black (10YR 2/1) mucky silt loam with common hemic and sapric plant fragments and contorted olive (5Y 5/3) silt loam strata (2–12 mm); massive; friable to slightly firm; common very fine and fine irregular, and few very fine, fine, and medium tubular pores; common roots of all grades, with very fine and fine decreasing to few near bottom; abrupt wavy boundary
Bw	20–25	Complex blend of dark yellowish-brown (10YR 4/4), olive brown (2.5Y 4/4), light olive brown (2.5Y 5/4), and brown (7.5YR 4/4) silt loam in zones commonly with dimensions of 3–10 mm, with common mottles characterized by coarse, prominent, clear and sharp, gray (5Y 5/1) interiors and medium, prominent, clear and sharp, strong brown (7.5YR 5/8) exteriors just below the A horizon; mostly strong and moderate fine and medium granular structure ranging to weak medium subangular blocky in a few places; friable; many very fine and fine irregular, and common very fine and fine tubular pores; few very fine, fine, and medium roots; abrupt wavy and discontinuous boundary
Ab	25–26	Black (N 2/) mucky silt loam discrete from A′ below but in most respects very similar; abrupt wavy and discontinuous boundary
A	26–38	Very dark grayish-brown (10YR 3/2) mucky silt loam, with abundant sapric remains of roots and plant materials ranging in color from very pale brown (10YR 7/4) to dusky red (10R 3/3) and reddish black (10R 2.5/1); scattered throughout the horizon is very fine olive gray (5Y 5/2) lentil-shaped silt loam; weak medium subangular blocky structure ranging downward to massive; friable; many very fine and fine irregular, and common very fine and fine tubular pores; common medium, and few very fine, fine, and coarse roots; clear wavy boundary
Cg1	38–46	Marbled olive gray (5Y 5/2, 75%, and 5Y 4/2, 25%) silt loam (slightly coarser than lower Cg horizons) with few fine faint cylindrical olive (5Y 4/4) quasiferrans around less than 10% of the albans surrounding the common very fine and fine tubular pores; massive; non-sticky, nonplastic; upper and lower boundaries have increasingly larger amounts of incorporated organic debris; no cutanic surfaces observed as seen in lower Cg's; very few very fine, fine, and medium roots; clear wavy boundary
Cg2	46–61	Dominantly olive gray (5Y 4/2) silt loam with <1% mottles as described for Cg1 is broken by thick (1–3 cm) very dark grayish-brown (10YR 3/2) mucky silt loam strata; throughout are 10–20% thin stringy and coarser disrupted olive gray (5Y 5/2) silt loam strata; generally massive, though parting to coarse angular blocks along sharp mineral–organic boundaries; slightly sticky, slightly plastic in mineral rich portions; in the organic rich strata are abundant sapric and hemic leaf remains; common very fine and fine tubular pores throughout as well as common very fine, fine, and medium irregular pores in the organic rich sections
Cg3	61–102	Olive gray (5Y 5/2) silt loam matrix (texture varying slightly as diffuse bands) with several slightly darker olive gray (5Y 4/2) bands 2–5 cm thick; 3% medium and coarse clear distinct olive brown (2.5Y 4/4) quasiferrans surrounding an olive gray (5Y 4/2)

		alban around 20% of the few very fine and fine tubular pores; massive; slightly sticky, slightly plastic; in darker bands there are what appear to be charred fragments (2–5 mm); common large subhorizontal stress or depositional cutans (in some places clods exhibit only very slight tendency to break along cutanic surfaces); few very fine and fine roots; abrupt smooth boundary
C	102–125+	Olive (5Y 4/3) coarse sand (first 5–8 cm borderline very coarse sand) with 10% coarse diffuse faint olive gray (5Y 5/2) matric mottles surrounded by distinct dark yellowish-brown (10YR 4/4) borders and adjacent to the few fine tubular pores, dark yellowish-brown (10YR 4/4) neoferrans (1 cm diameter) surrounded by olive gray (5Y 5/2) quasi-albans; single grain; nonsticky, nonplastic; few fine roots

SACO mucky silt loam
Site: 15
Taxonomic Class: Fluvaquentic Humaquept, coarse-silty, mixed, nonacid, mesic
Hydric Status: Hydric
Date Described: 9 November 1987
Location: Pilgrim Airport, Whately, Franklin County, Massachusetts

Horizon	Depth (cm)	Description
Oi	5–0	Fallen litter dominated by red oak leaves; abrupt smooth boundary
Oe/Oa	0–3	Very dusky red (2.5Y 2.5/2; rubbed) moderately to well humified litter; many very fine and fine roots; clear smooth boundary
A	3–9	Coarsely banded and turbated black (N 2/) muck and black (10YR 2/1) mucky silt loam with at least one variably turbated stratum (2 cm thick) of dark gray (5Y 4/1) silty clay loam at midhorizon, which where least mixed displays at lower boundary few coarse prominent clear yellowish-brown (10YR 5/6) mottles with olive brown (2.5Y 4/4) borders to matrix; moderate fine and medium granular structure common to organic rich parts with fine and medium subangular blocky structure present in mineral rich parts; very friable; many very fine and fine irregular pores, and common very fine and few fine tubular pores; many very fine and common fine, medium, and coarse roots; abrupt wavy boundary
C	9–19	Mixed dark brown (10YR 3/3) and very dark grayish-brown (2.5Y 4/2) silt loam matrix, with the latter color commonly observed as broad zones around tubular pores containing rotting roots and on ped faces; moderate medium subangular blocky structure becoming massive with depth; slightly firm, where structure is strongest, to friable; common inclusions of porous spongy material breaking readily into fine granules; few very fine tubular pores; common very fine, fine, and medium, and few coarse roots; abrupt smooth boundary
Ab	19–35	Coarsely stratified very dark brown (10YR 2/2; 60%) and black (10YR 2/1; 30%) mucky silt loam with thin gray (5Y 5/1) silty clay loam strata (<5 mm; the boundaries of which form parting surfaces to organic rich materials) and thin strata of hemic and sapric dark brown (7.5YR 3/4) through very pale brown (10YR 7/4) organic fragments; moderate coarse platy structure (imparted by differential deposition) parting readily to medium and coarse subangular blocks; friable; nonsticky, nonplastic; common very fine and fine tubular pores; many very fine, common fine, and medium, and few coarse roots; abrupt smooth boundary
ACg	35–53	Dark grayish-brown (2.5Y 4/2) silt loam with 25% medium and coarse faint clear cylindrical olive gray (5Y 4/2) mottles surrounding about half the tubular pores containing very dark brown (10YR 2/2) and dark yellowish-brown (10YR 3/4) very fine, fine, and medium decaying roots; massive; nonsticky, nonplastic; common very fine, fine, and medium tubular pores with the latter two commonly vertically oriented; few coarse, planar, vertically oriented organs (0.5 mm thick) with fine scale pitted and wrinkled surfaces; few very fine, fine, and medium roots; gradual smooth boundary

Cg	53–100	Dark gray (5Y 4/1) silt loam with occasional diffuse very fine sandy loam strata, the whole of which has 25% medium and coarse faint clear greenish-gray (5G 5/1) mottles surrounding about half the tubular pores containing decaying roots (as in the (ACg horizon); massive; slightly sticky, slightly plastic (on average); common very fine and fine predominantly vertically oriented tubular pores; few very fine and fine, and very few medium roots

SACO mucky silt loam
Site: 19
Taxonomic Class: Fluvaquentic Humaquept, coarse-silty, mixed, nonacid, mesic
Hydric Status: Hydric
Date Described: 26 October 1987
Location: Northfield (west of center), Franklin County, Massachusetts

Horizon	Depth (cm)	Description
A	0–28	Variable olive gray (5Y 4/2) and dark olive gray (5Y 3/2) silt loam with many variously sized prominent clear dark brown (7.5YR 3/4) and dark yellowish-brown (10YR 3/4) mottles; in less bioturbated zones the matrix is variably dark gray (5Y 4/1) and greenish gray (5GY 4/1) with brown mottles as described above; mottles are both matric and inconsistently expressed as neoferrans on pore walls (some roots are brown stained as well); moderate medium subangular blocky structure with granular zones interspersed (upper 4 cm generally has strong fine and medium granular structure); variably friable and very friable (variably nonsticky, nonplastic and slightly sticky, slightly plastic); common roots of all grades (many very fine and fine in top 4 cm), many very fine irregular and many very fine and common fine, medium, and coarse tubular pores; a coiled white worm (0.5 mm diameter) observed which matches closely in size the very fine tubular pores; abrupt (clear in places) smooth boundary
Cg1	28–38	Dark gray (5Y 4/1) silt loam matrix with 5% medium prominent clear brown (7.5YR 4/4) matric mottles throughout and common variously sized prominent dark yellowish-brown (10YR 4/6) neoferrans on many ped faces; moderate to weak with depth, medium subangular blocky structure (with some tendency to moderate medium platiness); friable (slightly sticky, slightly plastic); common very fine, fine, and medium and few coarse roots; many to common with depth very fine and fine irregular pores and common tubular pores of all grades; common poorly defined medium and coarse fine granular fillings of earthworm channels; on "plates" referred to above are common pale yellow (2.5Y 7/4) bleached leaf fragments (2–20 mm diameter); clear smooth boundary
Cg2	38–81	Dark gray (5Y 4/1) variable silt loam–silty clay loam matrix; dark gray (5Y 4/1) neoalbans (identical to general matrix) that pass clearly into olive brown (2.5Y 4/4) quasiferrans surround medium and large tubular pores and pore fillings; on average and in addition to the pore associated mottles are 3% medium and coarse distinct clear olive brown (2.5Y 4/4) and olive (5Y 4/4) matric mottles and ferrans on ped faces; massive, though a small portion exhibits weak coarse subangular blocky structure (pore-related); borderline friable–firm (slightly sticky, slightly plastic); few very fine, fine, and medium roots; many very fine and common fine tubular pores, few of which have ferrans; pore fillings mentioned above contain a very dark and dark grayish-brown (2.5Y 3 and 4/2) silt loam and have been mined by fauna to produce many fine tubular pores; clear smooth boundary
Cg3	81–137	Olive (5Y 4/3) silt loam with 40% medium and coarse faint olive gray (5Y 4/2) mottles in association with 5% distinct clear olive brown (2.5Y 4/4) mottles; few fine prominent yellowish brown (10YR 5/6 and 8) neoferrans and dark gray (5Y 4/1) quasialbans; common medium tortuous tubular pores with dark grayish-brown (10YR 4/2) organs, which in a few places are reddish black (5R 2.5/1); also present are a few large vertical planar surfaces with similar coatings and irregular pore structure; massive to coarse subangular blocky structure where planar organs are prominent; borderline friable–firm (slightly sticky and slightly plastic); few fine roots; many very fine and common fine tubular pores, most of which have high chroma ferrans; clear smooth boundary

Cg4	137–147	Dark gray (5Y 4/1) silt loam; massive, parting to fine and medium subangular blocky fragments; friable (slightly sticky, slightly plastic); networked with many very fine and common fine tubular pores, nearly all possessing strong brown (7.5YR 4/6) ferrans (those without ferrans appear to have no surface coating); common medium tortuous tubular pores with apparent dark grayish-brown (10YR 4/2) organs, which in some places fill pores to produce an irregular pore structure; around one of the larger pores is a thin neoalban with an olive brown (2.5Y 4/4) quasiferran (1.5 mm); gradual smooth boundary
Cg5	147–165	Olive gray (5Y 5/2) loamy fine sand with like-colored silt loam strata alternating 1–2 cm thick; the latter possess very fine and fine rooting pores, some of which have gray (5Y 5/1) neoalbans and irregular clear prominent light olive brown (2.5Y 5/6) quasiferrans (occupy 20–30% of strata), while other rooting pores show this pattern reversed; massive; very friable (nonsticky, nonplastic); common very fine tubular pores throughout; silt loam strata have common medium very dusky red (7.5R 2.5/2) root cork-lined tubular pores

LIMERICK silt loam
Site: 2
Taxonomic Class: Aeric Fluvaquent, coarse-silty, mixed, nonacid, mesic
Hydric Status: Hydric
Date Described: 2 September 1986
Location: Rainbow Beach, Northampton, Hampshire County, Massachusetts

Horizon	Depth (cm)	Description
01	0–2	Very dark grayish brown (2.5Y 3/2) silt loam; weak, fine subangular blocky structure with common strong and moderate medium granulated zones; friable; few fine tubular and common fine irregular pores; common very fine and few fine roots; abrupt smooth boundary, with common tonguing well into horizon 02
02	2–23	Olive (5Y 4/4) loamy very fine sand crushed matrix, with 10% dark grayish-brown (2.5Y 4/2) lenticular finer textured strata and 15% very dark grayish-brown (2.5Y 3/2; earthworm casts) and dark brown (7.5YR 3/4) coarse organic fragments; massive matrix, with strong and moderate medium granules in krotovinas; very friable; many fine and medium irregular pores in krotovinas and seams of organic material, and common medium tubular pores throughout; few very fine, fine, and medium roots; abrupt smooth boundary
03	23–38	Very dark grayish-brown (2.5Y 3/2) silt loam with 1% medium faint light olive brown (2.5Y 5/4) and olive gray (5Y 5/2) mottles; and with an upper boundary (1 cm thick) of dark gray (5Y 4/1) silt loam with 10% coarse prominent dark yellowish-brown (10YR 4/6) ferrans on larger pores; moderate medium and coarse subangular blocky structure with ped faces defined by strong fine and medium granular structured zones (some of which are present within blocky peds); friable (slightly sticky); common medium and few very fine tubular, and common medium and coarse irregular pores; common very fine and few fine, medium, and coarse roots; clear irregular boundary
04	38–79	Very dark grayish-brown (2.5Y 3/2) silt loam matrix with 3–30% (increasing with depth) distinct (1–10%) dark gray (5Y 4/1) and olive gray (5Y 4/2) and (2–20%) dark yellowish-brown (10YR 3/6) mottles; weak medium and coarse subangular blocky structure mostly parting part along zones of moderate fine and medium granular structure; friable (slightly sticky); few irregular but common very fine tubular pores; common very fine and few fine medium and coarse roots; clear wavy boundary
05	79–97	Olive gray (5Y 4/2) silt loam–very fine sandy loam matrix (55%) with 30% medium and coarse distinct and 15% medium prominent dark yellowish-brown (10YR 4/6) mottles; massive; friable; common very fine, fine, and ferran lined medium tubular pores; few roots of all grades; abrupt smooth boundary
06	97–114	Olive (5Y 5/3) loamy very fine sand matrix (50–70%) with cross bedded thin strata, some (10%) olive gray (5Y 5/2) silt loam and others (20–40%) dark brown (10YR 3/3) organic materials mixed with sand-sized mica; no mottles observed; massive; few very fine and fine tubular and irregular pores; few very fine and fine roots; clear wavy boundary

07	114–142	Dark grayish-brown (2.5Y 4/2 and 4/3) coarse silt loam–very fine sandy loam (60%) with 20% medium coarse distinct dark gray (5Y 4/1) and 20% medium and coarse distinct dark brown (7.5YR 3/4) mottles in bands with different textures and as neoalbans and quasiferrans associated with larger pores; massive, parting weakly to medium platy fragments; friable; common very fine, fine, and medium tubular pores; few (locally common) very fine, fine, and medium roots, some of which are decaying; abrupt smooth boundary
08	142–152	Olive gray (5Y 5/2) very fine sand to 147 cm, becoming olive (5Y 5/3) to 152 cm, with common dark yellowish-brown (10YR 4/6) matric mottles between 147 and 150 cm

LIMERICK silt loam
Site: 5
Taxonomic Class: Aeric Fluvaquent, coarse-silty, mixed, nonacid, mesic
Hydric Status: Hydric
Date Described: 5 November 1986
Location: Rainbow Beach, Northampton, Hampshire County, Massachusetts

Horizon	Depth (cm)	Description
01	0–17	Very dark grayish-brown (2.5Y 3/2) silt loam with common remnants of earthworm bridged olive (5Y 5/3) loamy very fine sand strata, the latter having 50% medium and fine faint olive brown (2.5Y 4/4) neoferrans and olive gray (5Y 4/2) quasialbans oriented inwardly from silt loam boundary; a few matrix ped faces are dark grayish brown (2.5Y 4/2); moderate medium and coarse subangular blocky structure; friable; few very fine, fine, and medium roots; common medium and few very fine and fine tubular pores; common very fine and fine irregular intergranular pores in earthworm channel fillings, few medium and coarse irregular pores; many medium tubular and large spherical fine granule filled earthworm channel fillings; abrupt smooth boundary
02	17–28	Olive (5Y 4/3) silt loam matrix (65%) with medium and coarse faint and prominent clear olive gray (5Y 4/2) and (15%) neoalbans around pores and 5% brown (7.5YR 4/4) and dark yellowish-brown (10YR 4/6) ferrans around channel fillings and plate fringes; parted plates show similar but more extensive neoferran expression (50–80% low chroma colors, 20–50% high chroma colors); weak coarse subangular blocky structure with some weak thick platy fragments where earthworm activity is less pronounced; friable; few roots of all grades; common medium and few fine and coarse tubular pores; common very fine and fine intergranular pores in channel fillings, and common coarse and few medium irregular earthworm derived pores; common medium tubular and common coarse spherical and irregular very dark grayish-brown (2.5Y 3/2) fine granule filled (15%) earthworm channels; abrupt smooth boundary
03	28–61	Olive gray (5Y 4/2) silt loam matrix with 20% (on average) of exposed ped faces possessing dark brown (7.5YR 3/4) and dark reddish-brown (5YR 3/4) ferrans on horizontal bedding surfaces and lentil-shaped pores (upper part much like horizon 02 but with less krotovinization and pore development); top 4 cm of horizon is a stiff olive gray (5Y 4/2) silty clay loam with 2% thin yellowish-brown (10YR 5/6) and dark yellowish-brown (10YR 4/4) quasiferrans around fine pores; weak coarse and very coarse subangular blocky structure derived from earthworm activity and original platy strata; few to common very fine and fine, common medium, and few coarse tubular pores; few coarse spherical voids; and few irregular pores of all grades, except at 46–51 cm, where few to many medium irregular voids occur as the result of partial krotovinization of planar voids; few very fine and fine roots; common very dark grayish-brown (2.5Y 3/2) krotovinas; abrupt smooth boundary
04	61–76	Olive (5Y 4/3 and 5/3) coarse silt loam sandwiching an olive gray (5Y 4/2) silt loam with 30% (on average) of exposed ped faces possessing dark brown 7.5YR 3/4 (in the coarse-silt loam) and dark brown 7.5YR 3/2 (in the silt loam) ferrans on lentil-shaped pores in varying degrees of openness; weak coarse subangular blocky structure (controlled by

		irregular pore distribution); friable; few roots of all grades; common medium and few coarse lentil-shaped irregular pores; common coarse irregular and spherical, partially granule filled krotovinas, some having very fine granule fillings; abrupt smooth boundary
05	76–102	Complex sequence of strata broken into six sections with respect to color and texture (other features are relatively consistent throughout): (a) 76–83 cm, stratified (45%) olive (5Y 5/3 and 5/4), 5% olive gray (5Y 4/2) very fine sand, and (50%) dark grayish-brown (2.5Y 4/2) loamy very fine sand (b) 83–87 cm, silt loam similar to middle portion of horizon 04 (c) 87–92 cm, olive (5Y 4/4) loamy very fine sand with 15% fine faint olive gray (5Y 4/2) and olive brown (2.5Y 4/4) mottles (d) 92–94 cm, like horizon 05(b) (e) 94–97 cm, like horizon 05(c) (f) borderline dark gray (5Y 4/2)–dark grayish-brown (2.5Y 4/2) silt loam with 40% of exposed surfaces possessing medium and coarse prominent sharp dark red (2.5YR 3/6) and dark reddish-brown (5YR 3/3) neoferrans; massive to very friable to weak medium and coarse subangular blocky structure, friable with coarser to finer textured strata; common fine and few very fine, medium, and coarse tubular pores; few to common medium irregular lentil-shaped pores; and few coarse spherical voids; few very fine, fine, and medium roots; few coarse irregular and spherical krotovinas, some with very fine but most with fine granulated interiors; a gray (5Y 5/1) neoalban (1 mm) surrounding the one very coarse tree root; abrupt smooth boundary
06	102–118	Complex sequence of strata broken into the following: (a) 102–106 cm, finely stratified (60%) dark brown (10YR 3/3) fine sandy loam with 40% olive gray (5Y 4/2) and light yellowish-brown (2.5Y 6/4) very fine sand (b) 106–110 cm, olive (5Y 4/3) coarse silt loam; very similar in all respects to horizon 04 coarse silt loam (c) 110–113 cm, dark grayish-brown (2.5Y 4/2) loamy very fine sand–very fine sandy loam (d) 113–117 cm, olive gray (5Y 4/2) and olive (5Y 4/3) loamy very fine sand with 20% fine faint olive brown (2.5Y 4/4) mottles throughout (e) 117–118 cm, dark gray (5Y 4/1) silt loam, with an olive brown (2.5Y 4/4) planar neoferran along upper boundary with (d); generally massive, parting weakly to thick platy fragments; very friable to friable with coarser to finer textures; few very fine and fine roots; few fine and medium tubular pores; many medium and common fine lentil-shaped irregular pores; few coarse spherical voids; earthworms present but no krotovinas observed; abrupt smooth boundary
07	118–137	Fine and medium thick strata of olive (5Y 4/3) very fine sand through olive gray (5Y 4/2) very fine sandy loam, with 10% fine and medium prominent sharp and clear dark reddish-brown (5YR 3/3) ferrans on tubular and lentil-shaped irregular pores; where strata alternate closely, 30% dark yellowish-brown (10YR 4/4) to olive brown (2.5Y 4/4) color occurs in sands, with the low chroma loams; in thicker sandy strata, 30% medium and coarse distinct dark yellowish-brown (10YR 4/4) and olive gray (5Y 5/2) mottles occur in an olive matrix; massive with a slight preference to part along strata; very friable (nonsticky, nonplastic); few very fine and fine tubular pores; few ranging in places to common irregular pores in finer material; few very fine and medium roots; lower half of horizon has common fibric inclusions in coarser layers; clear smooth boundary
08	137–146	Dark olive gray (5Y 3/2) coarse silt loam with 10% fine through coarse prominent dark reddish-brown (2.5YR 2.5/4) and dark red (2.5YR 3/6) ferrans, the fine ones associated with sapric fibers and the medium and coarse ones are randomly oriented on walls of irregular voids; massive; friable (nonsticky, nonplastic); few very fine and fine roots; few to common fine and few very fine and medium tubular pores and common medium and coarse irregular pores; few spherical voids; abrupt smooth boundary

09	146–175	Complex horizon broken into four sections for description: (a) 146–150 cm, coarsely and diffusely mottled olive gray (5Y 5/2) and olive brown (2.5Y 5/6) sand (b) 150–159 cm, olive (5Y 4/3) fine sand (70%) stratified with 10% thin olive brown (2.5Y 4/4) bands, 5% mica-rich stratum and 15% olive brown (2.5Y 4/4) matric mottles in lower part; an embedded hemic stick fragment has a gray (5Y 5/1) neoalban (c) 159–168 cm, coarsely banded dark gray (5Y 4/1) and olive gray (5Y 4/2) sand with 5% prominent clear very dusky red (2.5YR 2.5/2) neoferrans on root channels; common pieces of hemic and sapric bark fragments and other organic materials (d) 168–175 cm, dark greenish-gray (5GY 4/1) fine sand with 15% medium and coarse banded, tubular, and irregular prominent clear to diffuse red (2.5YR 4/6) ferrans on pore surfaces; massive; nonsticky, nonplastic; few roots; common tubular and irregular pores; abrupt smooth boundary
10	175–203	Complex horizon broken into three sections for description: (a) 175–183 cm, dark greenish-gray (5GY 4/1) fine sand with 2% coarse irregular prominent clear dark reddish-brown (5YR 3/4) mottles (b) 183–193 cm, interstratified black (5YR 2.5/1) hemic materials with lesser amounts of dark yellowish-brown (10YR 4/6) very fine sand (c) 193-203 cm, dark greenish-gray (5GY 4/1) coarse silt loam; massive; nonsticky, nonplastic; no roots; no biopores

LIMERICK silt loam
Site: 10
Taxonomic Class: Aeric Fluvaquent, coarse-silty, mixed, nonacid, mesic
Hydric Status: Hydric
Date Described: 3 September 1987
Location: Manhan Meadows—East, Northampton, Hampshire County, Massachusetts

Horizon	Depth (cm)	Description
A	0–2	Very dark grayish-brown (10YR 3/2) silt loam; few (1%) small prominent yellowish-red (5YR 5/8) mottles; moderate fine to medium granular structure; friable; matted with many fine roots, common medium roots and stolons also present; gradual wavy boundary
C1	2–13	Dark grayish-brown (2.5Y 4/2) silt loam; many (35%) fine to medium faint gray (5Y 5/1) and common (15%) fine distinct strong brown (7.5YR 4/6) mottles in a reticulate pattern, some of which occur as neoalban–quasiferrans about channels >1 mm, common (3%) 5YR 5/8 mottles also occur; structure grades from granular (as in the overlying horizon) to weak medium subangular blocky with depth; friable; many very fine to fine and common medium to coarse roots, with the larger roots often lined with thin grayish-brown (2.5 5/2) fine-silty coatings; many very fine to fine and common medium pores; gradual wavy boundary
C2	13–71	Ped interior: reticulate pattern of approximately equal amounts of gray (5Y 5/1), dark grayish brown (2.5Y 4/2), and strong brown (7.5YR 4-5/6-8); ped exterior: variegated pattern of 5Y 5/1 and 2.5Y 4/2, silt loam; common (15% and 5%, respectively) fine distinct dark yellowish-brown (10YR 4/6) and dark brown (7.5YR 3/4) stains; moderate coarse angular blocky structure; friable; faint to distinct gray (N5/) coatings line most >1-mm channels; common very fine to medium pores and roots; gradual wavy boundary
C3	71–103	Approximately same matrix and mottle colors as in horizon C2, except for common (3–5%) occurrence of fine prominent very dusky red (2.5YR 2.5/2) ferri-mangans on ped exteriors and channels; silt loam; structure is as in the C2 horizon but becomes weaker with depth; friable; common very fine to fine and few to common medium pores, plus occasional large (5 × 50–60 mm) lenticular chambers; many channels >1 mm have albanic coatings as in

		C2 horizon, frequently having prominent yellowish-red (5YR 5/8) neoferrans or they have organic coatings; common (2/cm^2) very fine, few to common (1/cm^2) fine, and few (<1/cm^2) medium roots; abrupt wavy boundary marked by very prominent iron-encrusted band described in next entry
C4	103–128	The top of this horizon is marked by a 6- to 8-mm-wide, irregular, wavy, somewhat cemented, strong brown (7.5YR 5/8) band with iron accumulation; below this is gray (5Y 5/1) very fine sandy loam; matrix colors grade through dark grayish brown (2.5Y 4/2) and dark brown (7.5YR 4/4) to yellowish red (5YR 4/6), approaching most fine to medium channels; massive, parting to 2–3 cm by 8–12 cm lenticular fragments, which are friable; few to common very fine to fine and few medium pores, many of which have albanic coatings as in the C3 horizon, commonly stained with faint to distinct diffuse grayish-brown (2.5Y 5/3) and prominent clear to sharp dusky red (10R 3/3) mottles; few very fine to fine roots

LIMERICK silt loam
Site: 18
Taxonomic class: Aeric Fluvaquent, coarse-silty, mixed, nonacid, mesic
Hydric Status: Hydric
Date Described: 3 November 1987
Location: Pauchaug Brook, Route 63, Northfield, Franklin County, Massachusetts

Horizon	Depth (cm)	Description
A	0–13	Very dark grayish-brown (2.5Y 3/2) silt loam that, where not bioturbated, possesses common medium and coarse distinct clear olive gray (5Y 4/2) mottles enclosed in dark yellowish-brown (10YR 4/6) rinds (1–2 mm); moderate fine and medium subangular blocky structure; very friable; many very fine and finer inter- and intrapedal irregular and common very fine tubular pores; many very fine and common fine fern roots (very fine roots becoming common with depth); clear smooth boundary
ACg1	13–25	Dark olive gray (5Y 3/2) and olive gray (5Y 4/2) silt loam matrix, much turbated to very dark grayish-brown (2.5Y 3/2; 20%) unaltered and compressed fine granular earthworm channel fillings; matrix mottles (20%) are mostly fine distinct dark yellowish brown (10YR 4/6) with clear transitions to medium distinct olive brown (2.5Y 4/4) borders with clear transitions to matrix; few fine prominent reddish-black (10R 2.5/1) mangans on ped faces; weak medium subangular blocky structure (controlled by bioturbation); friable; common very fine and fine roots; many very fine and fine irregular pores (resulting from earthworm activity); common tubular pores of all grades with the larger ones being earthworm channels (these are vertically oriented and none possess ferrans); clear smooth boundary
ACg2	25–38	A three-part sequence of equi-thick dark olive gray (5Y 3/2), olive gray (5Y 4/2), and dark olive gray (5Y 3/2) silt loams which have been partially bioturbated; common fine and medium prominent clear dark yellowish-brown (10YR 4/6) matric mottles; 5–10% dark reddish-brown (2.5YR 3/4) and dark red (2.5YR 3/6) ferrans coat all open pores, except larger unfilled tubular pores have dark gray (5Y 3/2) cutans; in upper part are few fine prominent reddish-black (10R 2.5/1) quasimangans associated with living roots, common patchy fine and medium mangans on some horizontal faces, and when precipitated in matrix manangese oxide tends to be interior to ferric oxide, which is interior to gleyed matrix; massive, parting weakly to coarse subangular blocks where biota most active; friable; common decreasing to few very fine roots with depth; common tubular pores of all grades; few very fine and fine irregular ferran coated pores associated with bioturbation; few medium and large spherical nonferran coated pores; common fine granular medium and large dark olive gray (5Y 3/2) earthworm channel fillings; very coarse sands described in Cgl have apparently been mixed into BCg2; clear smooth boundary

Cg1	38–71	Dark gray (5Y 4/1, 30% upper-50% lower) and olive (5Y 4/3, 60% upper–30% lower) silt loam with olive transition zones between low chroma matrix and the 10% (upper) to 20% (lower) neoferrans (as in Cg2) around pores; active rooting pores are surrounded by either solely dark gray (5Y 4/1) matrix or by dark gray neoalbans where matrix is olive; at 38 and 46 cm are two poorly organized or contorted brown (10YR 4/3) fine gravelly very coarse sand strata; the 2–4 cm above the 46 cm sand band is as described for lower half of horizon; massive; friable (nonsticky, very slightly plastic); pores and ferrans like Cg2; thickest ferrans approach 2 mm on some large tubular pores (which are mostly vertically oriented); clear smooth boundary
Cg2	71–84	Horizon subdivided into three parts for description: (a) 71–76 cm, dark gray (5Y 4/1) silt loam with common distinct clear olive brown (2.5Y 4/4) and to a lesser extent dark yellowish-brown (10YR 4/6) mottles of all size grades surrounding most ferran coated pores (some of these "bleed" narrowly through olive gray (5Y 5/2) to matrix) (b) 76–81 cm, very dark gray (5Y 3/1) silt loam with few medium distinct clear olive gray (5Y 5/2) matrix mottles and fewer of the pore associated high chroma mottles described for Cg2(a) (c) transitional zone to C Other features common to the Cg2 horizon as a whole are: massive, slightly sticky, slightly plastic; common very fine and fine and common medium and coarse tubular pores (the larger ones are nearly exclusively vertically oriented); all pores possess dark red (2.5YR 3/6) or dark reddish-brown (2.5YR 3/4) ferrans (some larger pores approach 1 mm thickness); few very fine roots; clear smooth boundary
C	84–110+	Olive (5Y 4/4) silt loam matrix with 10% medium and coarse faint clear olive brown (2.5Y 4/4) mottles and 3% medium and coarse distinct sharp olive gray (5Y 5/2) mottles most commonly immediately adjacent to living roots, and common dark red (2.5YR 3/6) pore ferrans (adjacent matrix varying from standard matrix to gleyed olive gray); massive, parting weakly to coarse subangular blocky fragments; slightly sticky, nonplastic; common very fine tubular and irregular pores (20% with ferrans) and common medium and coarse tubular pores and planar voids, most with ferrans; few and common very fine roots

LIMERICK silt loam
Site: 1
Taxonomic Class: Aeric Fluvaquent, coarse-silty, mixed, nonacid, mesic
Hydric Status: Nonhydric
Location: Rainbow Beach, Northampton, Hampshire County, Massachusetts

Horizon	Depth (cm)	Description
01	0–2	Very dark grayish-brown (2.5Y 4/2) loamy very fine sand; massive; very friable; few very fine roots; abrupt smooth boundary
02	2–25	Olive (5Y 5/3) very fine sand with dark grayish-brown (2.5Y 4/2) lenticules (1–3 mm thick) of very fine sandy loam occupying 10–15% of horizon; massive; very friable; few very fine and fine roots; abrupt smooth boundary
03	25–37	Very dark grayish-brown (2.5Y 3/2) silt loam; massive, parting to weak medium and coarse subangular blocky fragments; friable; many very fine and common fine and medium tubular pores; common very fine and few fine, medium, and coarse roots; very small white worm associated with very fine pores; clear smooth boundary
04	37–57	Dark grayish-brown (2.5Y 4/2) silt or silt loam (low clay content) with 1% medium very faint light olive brown (2.5Y 5/4) mottles, massive, parting to weak medium and coarse subangular blocky fragments; friable; common very fine, fine, and medium tubular pores; common roots of all grades; small (1 cm $\times$ 3 cm) insect larvae; vestiges of original stratification still present; but for most part it has been obliterated by pedoturbation; gradual wavy boundary

05	57–110	Very dark grayish-brown (2.5Y 4/2) silt loam marbled to a minor extent with grayish-brown (2.5Y 5/2) very fine sand and olive gray (5Y 4/2) silt loam strata, with 1% medium very faint light olive brown (2.5Y 5/4) and faint olive gray (5Y 5/2) mottles in sandier sections; generally massive, but ranges to weak medium and coarse subangular blocky structure where worm activity greatest; none to many very fine and fine and common medium tubular pores, common very fine and few fine, medium and coarse roots; clear smooth boundary
06	110–152+	Stratified, olive (5Y 4/3) loamy very fine sand and olive gray (5Y 4/2) very fine sandy loam with 2% fine and medium distinct dark yellowish-brown (10YR 3/6) matric mottles; massive; very friable; few very fine and fine roots

LIMERICK silt loam
Site: 4
Taxonomic Class: Aeric Fluvaquent, coarse-silty, mixed, nonacid, mesic
Hydric Status: Nonhydric
Date Described: 8 October 1986
Location: Rainbow Beach, Northampton, Hampshire County, Massachusetts

Horizon	Depth (cm)	Description
01	0–2	Very dark grayish-brown (2.5Y 3/2) silt loam; moderate medium and coarse subangular blocky structure with strong fine granules separating peds; friable; common very fine and few fine roots; many medium and common fine tubular pores; many very fine, fine, and medium irregular pores; many earthworms observed; abrupt smooth boundary with irregular bridges to horizon 03
02	2–7	Olive (5Y 5/3) loamy very fine sand; weak medium platy structure where not disturbed by horizons 01–03 bridging by earthworms where medium and coarse subangular blocky fragments are common; very friable; few very fine, fine, and medium roots; common medium and coarse tubular pores; many medium and coarse tubules filled with fine and medium granules; abrupt smooth boundary
03	7–16	Very dark grayish-brown (2.5Y 3/2) silt loam; moderate medium and coarse subangular blocky structure with fine–medium granular surfaces and interpeds; friable, 3% medium and coarse faint olive gray (5Y 4/2) and fine and medium faint olive brown (2.5Y 4/4) mottles occuring mostly in zone less severely or less recently mixed by earthworms; few very fine, fine, and medium roots; common medium and large, and few fine tubular pores; many very fine, and common medium and coarse irregular pores; common medium and coarse granule filled tubules; abrupt to clear smooth boundary
04	16–38	Dark grayish-brown (2.5Y 4/2) silt loam; weak medium and coarse subangular blocky structure; friable (very slightly sticky and very slightly plastic); 10% medium faint olive gray (5Y 4/2) mottles with fine prominent strong brown (7.5YR 5/6) and faint olive brown (2.5Y 4/4) rinds, which at 22 and 29 cm occur in a stratified arrangement; few roots of all grades; many very fine and common fine, medium, and large tubular pores; common medium, and large irregular or spherical pores; common medium and large tubulic and spherical fillings; abrupt wavy boundary possibly due to the effect of a large tree nearby on water flow during flooding
05	38–60	Closely spaced (<1 mm) dipping and truncated strata of olive (5Y 5/3) fine sands through dark grayish-brown (2.5Y 4/2) silt loams (averaging out to a loamy very fine sand); weak to moderate thin platy structure; friable; common large and medium, and few very fine and fine roots; generally few tubular pores of all grades; many localized very fine and fine irregular pores; common vertically oriented large filled and partially filled tubules, some of which are faintly mottled olive gray (5Y 4/2) and olive brown (2.5Y 4/4) in more silty zones; abrupt smooth to wavy boundary

06	60–85	Dark grayish-brown (2.5Y 4/2) silt loam matrix with 10% medium and coarse faint olive gray (5Y 4/2) and olive brown (2.5Y 4/4) mottles; two olive gray (5Y 4/2) finer silt loam layers (1 cm thick) in upper few centimeters of horizon, mottled strong brown (7.5YR 5/6) and dark yellowish brown (10YR 4/6) at boundaries; an olive (5Y 5/3) very fine sand stratum (2-cm thick) at midhorizon and the vestige of one at the base of the horizon; some sand filled tubules; weak medium and coarse subangular blocky structure in the lower part, moderate thin and medium platy structure in the upper part; few roots of all grades, two roots of 12-mm diameter; common fine and medium, and few large tubular pores; common very fine and fine, and common to many medium and large irregular pores; lower half of horizon well worked by earthworms, while upper half less so; clear smooth boundary
07	85–130	Moderately thick strata (1–2 cm) of olive (5Y 5/3 [30–40%] and 5Y 4/3 [50–60%]) very fine sandy loams and coarse silt loams (upper half of the horizon being much more earthworm-worked than lower half); 5% olive gray (5Y 4/2) bands mottled olive brown (2.5Y 4/4) around pores and 0.5 cm around bands; in upper part around some dark grayish-brown (10YR 4/2) krotovinas are distinct yellowish-brown (10YR 5/8) mottles, surrounded by olive gray (5Y 4/2) haloes; weak to moderate subangular blocky structure in the upper part, and weak to moderate fine and medium platy structure in the lower part; friable; few very fine, fine, and medium roots; common very fine, fine, and medium tubular pores, and common large irregular and spherical pores, some filled with fine granules in the upper part (lower part similar but with many medium and coarse granule filled tubules and common medium spherical krotovinas); clear smooth boundary
08	130–152	Olive (5Y 5/3) loamy very fine sand, with large faint olive gray (5Y 4/2) and medium distinct yellowish-brown (10YR 5/6) and dark reddish-brown (5YR 3/3); with yellowish-brown outer rind mottles that overall occupy 10% of horizon (some zones are mottle-free, others have more than 10% most commonly associated with rooting and textural variations in strata); rooted pores are surrounded by high chroma colors in low chroma enclosures and finer textured zones are low chroma colored with high chroma borders; throughout a small proportion of the unrooted pores are mottled; weak medium platy structure to massive; very friable; few very fine and fine roots; common very fine, fine, and medium tubular pores; abrupt smooth boundary
09	152+	More distinctly stratified and mottled layers with an olive gray (5Y 4/2) silt loam layer at 152–157 cm, below which lies dark reddish-brown (5YR 3/4) sand

RIPPOWAM fine sandy loam
Site: 8
Taxonomic Class: Aeric Fluvaquent, coarse-loamy, mixed, nonacid, mesic
Hydric Status: Hydric
Date Described: 4 August 1988
Location: West Hatfield, Hampshire County, Massachusetts

Horizon	Depth (cm)	Description
A	0–3	Dark brown (10YR 3/3) fine sandy loam; weak fine subangular blocky structure; very friable; coarse, common medium, and many very fine roots; few medium irregular, few medium constricted and continuous tubular and many fine and very fine continuous tubular pores; common coarse vertical channels frequently containing worms; abrupt wavy boundary
ACg	3–20	Grayish brown (10YR 5/2) fine sandy loam with common fine faint irregular clear yellowish-brown (10YR 5/6) and few fine irregular dark gray (10YR 4/1) mottles; weak to moderate fine subangular blocky structure; friable; few coarse and many very fine roots; few medium irregular and common (totaling 2%) very fine continuous tubular pores; lustrous ped surfaces, many thin light gray (5Y 7/1-2) channel cutans, a dark gray (5Y 4/1)

		organ (3–4 mm) inside a gray (2.5Y 5/0) alban (6–7 mm) inside a brownish yellow (10YR 6/8) quasiferran (2–3 mm) surrounds a worm channel from surface, few to common neoalban–quasiferrans (2.5Y 5/2 with 10YR 5/8 rind) surround the remaining worm channels; few to common fine firm (1 mm) iron and manganese nodules starting at 10–15 cm; abrupt irregular boundary
Cgl	20–43	Light brownish-gray (10YR 6/2) fine sandy loam with many medium gray (2.5Y 6/0) tongued mottles from below, surrounded by common fine prominent clear reddish- yellow (7.5YR 6/6) streaked mottles with few common fine faint pink (7.5YR 7/4) mottles scattered through matrix and common fine very dark grayish-brown (10YR 3/2) mottles starting at 30 cm and increasing in amount with depth; weak medium platy structure; friable; few very fine roots; 0.5% very fine continuous pores and 0.1% medium and 0.5% coarse vughs; slightly lustrous ped surfaces, gray cutans on vugh walls are moderately thick at bottom of horizon, light gray (5Y 7/1-2) channel cutans are moderately thick throughout the horizon with some constriction in the lower horizon, few to common worm channels with neoalban–quasiferrans, as in the overlying horizon; firm iron nodules increase from 1 to 5 mm in size and increase amount (common to many) with depth, few fine manganese nodules; gradual wavy boundary
Cg2	43–56	Mixed light brownish-gray (10YR 6/2) and gray (2.5Y 6/0) fine sandy loam with many prominent clear reddish-yellow (7.5YR 6/6) streaked mottles and few to common faint clear irregular pink (7.5 YR 7/4) mottles; weak medium platy structure; friable to firm with depth; few very fine roots; few (0.5%) very fine tubular pores, some discontinuous, and few (0.5%) coarse vughs; common light gray channel cutans vary from thin to moderately thick; common firm 5–10 mm diameter and many firm 1–2 mm diameter iron nodules; clear smooth boundary
Cm	56–60	Mixed grayish-brown (2.5Y 5/2) and yellowish-red (5YR 4/6) fine sandy loam; massive; cemented; iron nodules have concentrated into very to extremely firm pan of interlocked medium plates with friable matrix between plates; clear smooth boundary
2Ab	60–66	Mixed brown (10YR 5/3) and gray (2.5Y 5/0) fine sandy loam with common to many fine dark yellowish-brown (10YR 4/6) streaked mottles around gray tongued mottles from above; weak fine platy structure; very friable; few (0.1%) very fine continuous random tubular pores; few light gray channel cutans as in BCg; common fine iron and manganese nodules; abrupt irregular boundary
2Cb1	66–83	Grayish-brown (10YR 5/2) loamy fine sand with common faint coarse dark brown (10YR 4/3) mottles; weak fine angular blocky structure; very friable; few (0.1%) very fine continuous random tubular pores; few moderately thick light gray channel cutans; common (3%) fine iron nodules; abrupt irregular boundary
2Cb2	83–100	Dark brown (10YR 4/3) medium to fine sand with common faint medium dark yellowish-brown (10YR 4/4) mottles; weak medium platy structure; unconsolidated; common fine iron nodules; abrupt smooth boundary
3C	100+	Dark yellowish-brown (10YR 3/6) coarse sand; unconsolidated (>20 cm thick)

WINOOSKI silt loam, variant
Site: 12
Taxonomic Class: Aquic Udifluvent, coarse-silty, mixed, nonacid, mesic
Hydric Status: Hydric
Date Described: 26 September 1987
Location: Pynchon Meadows, Northampton, Hampshire County, Massachusetts

Horizon	Depth (cm)	Description
Ap	0–23	Very dark brown (10YR 2/2) at the top, to dark brown (10YR 3/3) silt loam; common (3%) fine distinct diffuse strong brown (7.5YR 5/6) mottles; structure grades from weak very fine granular, at the top, to moderate medium subangular blocky; friable; many very fine to medium and common coarse pores and roots; abrupt slightly wavy boundary

C1	23–62	Reticulate pattern of dark brown (7.5YR 3/3) and slightly lesser amounts of olive gray (5Y 5/2) loam, with a 1- to 2-cm band of slightly coarser-textured codominant yellowish-brown (10YR 5/6) and grayish-brown (2.5Y 5/3) material running oblique to the surface between 30 and 40 cm; distinct channel neoalban–quasiferrans, gray (5Y 5/1) with strong brown (7.5YR 5/8) rinds, begin at approximately 32 cm and become more abundant with depth; weak coarse subangular blocky structure; friable; many very fine to fine and common medium to coarse pores, with pores >1 mm frequently having organic coatings, some of which are bark linings that, in turn, often have a coating of fine sand on their exteriors; common very fine to medium and few coarse roots; gradual wavy boundary
C2	62–103	Reticulate pattern of dark brown (10YR 3/3) and lesser amounts of gray to olive gray (5Y 5/1-2) silt loam; many coarse dark brown (7.5YR 3/4) mottles stain ped faces; channel neoalban–quasiferrans, with yellowish-red (5YR 4-5/6-8) rinds are abundant and 5YR 4/6 channel ferrans occur starting at approximately 93 cm; weak to moderate coarse subangular blocky structure; friable; many very fine to fine commonly coating ped exteriors; very friable to friable; many very fine to fine, common medium, and few coarse pores with organic coatings as in the overlying horizon, thin dark grayish-brown (2.5Y 4/3) silt often coating >1-mm channels; common very fine to medium and few coarse roots, with the finer roots frequently concentrated within channels >1 mm; gradual wavy boundary
C3	103–133+	Reticulate pattern of codominant dark brown (10YR 3/3) and gray (5Y 5/1) fine sandy loam; common (12–14%) fine to medium faint to distinct dark brown (7.5YR 3/2) mottles and common dark brown to black (7.5YR 2-3/4-0) channel neoferrans; massive very friable (at near-saturation); many (7/cm^2) very fine and common fine to medium pores, frequently having dark brown (7.5-10YR 3/2-3) silty coatings; common very fine to medium roots

WINOOSKI silt loam
Site: 13
Taxonomic Class: Aquic Udifluvent, coarse-silty, mixed, nonacid, mesic
Hydric Status: Nonhydric
Date Described: 1 November 1987
Location: Pilgrim Airport, Whately, Franklin County, Massachusetts

Horizon	Depth (cm)	Description
Oi/Oe	5–0	Fresh and moderately decomposed leaf litter, predominantly oak and maple; abrupt smooth boundary
Oa	0–2	Reddish-black (10R 2.5/1) loosely packed humus; weak fine granular structure; very friable; many very fine to medium packing voids; many very fine and common fine, medium and coarse roots; abrupt smooth boundary
A	2–4	Very dusky red (2.5YR 2.5/2) through dark yellowish-brown (10YR 3/4) silt loam; weak fine subangular blocky structure; very friable; common very fine tubular and irregular pores; many roots of all grades; abrupt smooth boundary
Bw1	4–14	Dark yellowish-brown (10YR 4/6) silt loam with common olive brown (2.5Y 4/4) ped faces; moderate fine to medium subangular blocky structure; very friable to friable; nonsticky, nonplastic; few very fine and fine tubular and many very fine irregular pores; common

		roots of all grades (though many very fine in upper part); few very fine fungal strands; generally clear smooth boundary (locally wavy)
Bw2	14–30	Olive brown (2.5Y 4/4) silt loam (lower part grades to very fine sandy loam) with common olive (5Y 4/4) ped faces; moderate fine and medium subangular blocky structure with the horizontal faces being somewhat better developed such that in places a medium platy structure is expressed; friable; weakly preserved (or developed) very thin stress or depositional cutans on ped faces; many very fine irregular and few fine tubular pores; few 1-cm spherical cavities; common very fine and fine, and few medium and coarse roots; common medium and coarse black (10YR 2/1) decaying roots; clear smooth boundary
BC1	30–46	Olive brown (2.5Y 4/4) very fine sandy loam with <1% ranging to 5% with depth medium faint clear olive (5Y 4/3) matric mottles with olive brown (2.5Y 4/4) borders (an occasional olive gray [5Y 4/2] to light olive brown [2.5Y 5/6] pair observed); massive to weak medium subangular blocky structure; slightly firm; common very fine and fine tubular, and common very fine irregular pores; few very fine and fine roots; few fine and common medium tubular casts filled with material similar to or slightly more sandy than matrix; clear wavy boundary
BC21	46–64	A large irregular lentil-shaped outcropping across most of the front face of the pit; predominantly mixed brown (10YR 4/3) and olive brown (2.5Y 4/4) loamy sand–sandy loam with common contorted inclusions of like-colored fine sandy loam and olive yellow (2.5Y 6/6) sand, with 5–10% faint large clear and diffuse mostly olive (5Y 4/3) neoalbans mottles with light olive brown (2.5Y 5/6) quasiferrans centered around pores containing decaying roots (this pattern intensifies to olive gray [5Y 4/2] and dark yellowish brown [10YR 4/6], respectively, in a few places); generally massive, parting to coarse subangular blocky fragments with some pedlike faces exhibiting dark yellowish-brown (10YR 4/4) stress or depositional cutans; firm (single grain, very friable in sandy sections); loamiest sections are very similar to BC22; very few very fine and fine tubular and common very fine irregular pores; few very fine roots; few medium and coarse tubular casts as in BC1; a large junctioned 10-cm burrow littered with A horizon material exits from middle of horizon; clear discontinuous boundary
BC22	64–89	Mixed olive brown (2.5Y 4/4; 50%) and olive (5Y 4/4; 25%) variable silt loam and very fine sandy loam matrix, with 15% dark yellowish-brown (10YR 4/6) and yellowish-brown (10YR 5/6) and 10% olive gray (5Y 4/2) mottles; this arrangement gives way to a 50–50% matrix–mottle distribution with depth and proximity to significant rooting (in one zone olive gray [5Y 4/2; 60%] becomes matrix color around a concentration of medium roots with high chroma mottles exterior); massive but occasionally parting to coarse subangular blocks along olive (5Y 4/3) coated ped faces in zones well penetrated by roots moderate medium and coarse angular blocky peds break out; sightly firm; common very fine tubular and irregular pores; few very fine, fine and medium roots; abrupt smooth boundary with small scale irregularities.
C	89–190	Light olive brown (2.5Y 4/4) subtly alternating coarse sand–sand—top 4 cm is dark yellowish brown (10YR 4/4), with few prominent manganese oxide concretions (1–3 mm) peppered through a band between 91 and 100 cm and again between 152 and 155 cm; below the latter the coarse sand becomes olive brown (2.5Y 4/4) to 158 cm, then yellowish red (5YR 5/8) to 162 cm; below 162 cm: olive gray (5Y 4/2) coarse sand with many large diffuse olive brown (2.5Y 4/4) matric mottles; single grain; nonsticky, nonplastic; no pores or roots observed; 0% gravel

WINOOSKI silt loam
Site: 17
Taxonomic Class: Aquic Udifluvent, coarse-silty, mixed, nonacid, mesic
Hydric Status: Nonhydric
Date Described: 21 October 1987
Location: Mount Hermon, Gill, Franklin County, Massachusetts

Horizon	Depth (cm)	Description
Oi	5–0	Relatively fresh litter of predominantly maple, white pine, with some birch, oak, and cherry; abrupt wavy boundary
Oe–Oa	0–3	Abundantly rooted moderately and well humified dark reddish-brown (5YR 3/2 field moist) litter of past vegetation; abrupt wavy boundary
AC	3–6	Olive brown (2.5Y 4/4) very fine sandy loam; massive, parting moderately well to medium subangular blocky fragments; very friable; common very fine and fine and few medium and coarse roots; abrupt wavy boundary with small scale irregularities
Ab	6–7	Very dark grayish-brown (2.5Y 3/2) very fine sandy loam; massive, parting moderately well to medium subangular blocky fragments; very friable; common very fine, fine, and medium and few coarse roots; abrupt wavy boundary
BA	7–17	Olive brown (2.5Y 4/4) very fine sandy loam (slightly browner near top); massive, parting moderately to medium subangular blocky fragments to zones of weak medium subangular blocky structure with faint color–lustre variations on ped surfaces; friable; common very fine, fine and medium and few coarse roots; few fine tubular pores; a thin (1 cm) discontinuous Ab′, very similar to Ab described above, is visible around 25% of pit face ranging from distinct to absent; clear wavy boundary
Bw1	17–33	Olive brown (2.5Y 4/4) very fine sandy loam (of slightly lighter value than BA) with 30% light olive brown (2.5Y 5/4) and slightly darker olive brown (2.5Y 4/4) zones throughout; massive, parting weakly to large subangular blocky fragments; friable; few root of all grades; few fine and medium tubular pores; few medium and coarse root cork-lined tubular pores; clear wavy boundary
Bw2	33–46	Olive brown (2.5Y 4/4) relatively sandy very fine sandy loam with 1% medium irregular distinct clear olive gray (5Y 5/2) matric mottles bordered by 5% medium irregular distinct clear dark yellowish-brown (10YR 4/6) mottles; massive, parting weakly to large subangular blocky fragments; friable; few roots of all grades; few fine and medium tubular pores, and few medium and coarse root cork-lined tubular pores; clear wavy boundary
BC	46–61	Olive (5Y 4/4) very fine sandy loam with 2–3% medium irregular faint clear olive gray (5Y 5/2) matric mottles, best expressed when bordered by the 10% medium and coarse irregular distinct clear and sharp dark yellowish-brown (10YR 4/6) and prominent strong brown (7.5YR 4/6) mottles; 30% variegated olive (5Y 5/3) and olive brown (2.5Y 4/4) mottled zones throughout; massive, parting moderately to medium and coarse subangular blocky fragments; friable; <1% gravel; few roots of all grades; few very fine (become common in a few places) and fine tubular pores; few medium and coarse root cork-lined tubular pores; few larval chambers (2.5–3 mm diameter) cased in thin ferrans; clear wavy boundary
C1	61–91	Olive (5Y 4/4) sandy very fine sandy loam with few scattered loamy sand inclusions with 5% medium diffuse olive gray (5Y 5/2) mottles bleeding through olive (5Y 5/3) to matrix color on one side and bordered clearly by 20% dark yellowish-brown (10YR 4/6) and 2% strong brown (7.5YR 4/6) matric mottles on the other side; the latter high chroma colors are occasionally associated with the very fine pores and coarser textures; higher chroma mottles are also very weakly cemented; massive, parting weakly to medium and coarse

		subangular blocks; friable; few very fine, fine, and medium roots; few very fine and fine tubular pores (very fine are common in a few places); <1% fine phyllitic gravel; clear wavy boundary
C2	91–142	Olive brown (2.5Y 4/4) fine sand (70%) and loamy fine sand with an olive gray (5Y 5/2) gravelly sand body (20 × 10 cm cross section); loamier section is much like C1 horizon, is located near the sand body, and possesses discontinuous coarse sand bands; fine sand section has olive gray (5Y 4/2) and dark yellowish-brown (10YR 4/6) mottles associated with somewhat sandier bands; few light yellowish-brown (10YR 6/4) coarse sand lenses (1 cm thick); massive; friable (very weakly cemented sand); few very fine and fine roots; few very fine and fine tubular pores; abrupt smooth boundary
Cm	142–160	Light olive brown (2.5Y 5/4) very coarse sand with common coarse diffuse yellowish-brown (10YR 5/4) mottles; manganese oxide has cemented the surface 1–2 cm of horizon, which extends as a network at least 20 cm downward

POOTATUCK fine sandy loam
Site: 9
Taxonomic Class: Fluvaquentic Dystrochrept, coarse-loamy, mixed, mesic
Hydric Status: Nonhydric
Date Described: 1 November 1987
Location: West Hatfield, Hampshire County, Massachusetts

Horizon	Depth (cm)	Description
Oi	2–0	Matted layer of predominantly oak leaves (with a minor maple leaf fraction); abrupt smooth boundary
Oe–Oa	0–2	Loosely packed very dusky red (2.5YR 2.5/2) hemic layer (0.5 cm) over a black (10YR 2/1) sapric layer (1.5 cm); moderate medium and coarse granular structure; very friable; many very fine and fine, and common medium and coarse roots; abrupt smooth boundary
A	2–9	Very dark grayish-brown (2.5Y 3/2) silt loam with 20% Oa and Bw1 material incorporated; weak medium subangular blocky structure, which borders on thick platy in relatively root free zones; very friable; common roots of all grades; common to many very fine irregular and few very fine and fine tubular pores; ped faces are slightly pitted and eroded; abrupt smooth boundary with small scale irregularities
Bw1	9–20	Mixed dark yellowish-brown (10YR 3/6 and 4/4 and 3/4) and olive brown (2.5Y 4/4) silt loam (10YR 3/6 rubbed) with few medium irregular faint clear light olive brown (2.5Y 5/4 and 5/6) mottles in zones with olive brown matrix; weak coarse subangular blocky structure; friable; generally few root of all grades, with fine and medium common locally; common very dusky red (2.5YR 2.5/2) rotting roots of all grades; slightly lustrous pedfaces are intricately perforated with very fine irregular pores; few very fine, fine, and medium tubular pores; few coarse contorted tubular krotovinas filled with organic-rich material; few very fine fungal strands throughout; abrupt wavy boundary
Bw2	20–33	Olive brown (2.5Y 4/4) silt loam with 2% medium and coarse irregular faint clear light olive brown (2.5Y 5/4 and 5/6) matric mottles; weak coarse subangular blocky structure; friable; few roots of all grades; slightly lustrous ped faces intricately perforated with very fine irregular pores; common very dusky red (2.5YR 2.5/2) rotting roots of all grades and common medium and coarse root cork-lined tubular pores; few very fine, fine, and medium tubular pores with thin stress cutans; few very fine fungal strands throughout; clear wavy boundary
BC	33–67	Light olive brown (2.5Y 5/4) loamy fine sand (passing to fine sandy loam and fine sand in places) with a coarse network of olive (5Y 5/3) mottles with coarse diffuse olive brown (2.5Y 4/4) rinds; massive; friable (nonsticky, nonplastic); few thin weakly developed

		planar stress cutans; few living roots of all grades; common medium and coarse dark reddish-brown (5YR 3/2) roots, some possibly bioturbated and krotovinized with surface materials (only a few support broad gleyed olive gray [5Y 5/2] irregular border zones or the neoalban–quasiferran feature described for C horizon); very fine and fine tubular pores; diffuse wavy boundary
C	67–80	Light olive brown (2.5Y 5/4) sand matrix with a coarse network of olive (5Y 5/3) mottles with large diffuse olive brown (2.5Y 4/4) rinds; single grain; nonsticky, nonplastic; few fine roots; few fine and medium tubular pores, most possessing faint neoalbans; the medium pores containing dark reddish-brown (5YR 3/3) rotted roots or root cork linings possess dark yellowish-brown (10YR 4/6) neoferrans; around one root extending down left side of pit is an olive gray (5Y 5/2) neoalban (3 mm) enclosed by a dark yellowish-brown (10YR 4/6) quasiferran (2–3 mm); diffuse smooth boundary
Cg	80–150	Olive gray (5Y 5/2) sand (slightly coarser than C) with 2% medium and coarse distinct diffuse light olive brown (2.5Y 5/4) matric mottles and olive brown (2.5Y 4/4) and dark yellowish-brown (10YR 4/6) neoferrans (1 mm thick) around the few fine tubular pores; single grain; nonsticky, nonplastic

HADLEY silt loam
Site: 16
Taxonomic Class: Typic Udifluvent, coarse-silty, mixed, nonacid, mesic
Hydric Status: Nonhydric
Date Described: 30 October 1987
Location: Route 63, Northfield, Franklin County, Massachusetts

Horizon	Depth (cm)	Description
Oi	5–0	Loose leaf litter of current vegetation; abrupt smooth boundary
Oe–Oa	0–3	Dark reddish-brown (5YR 3/2) to black (5YR 2.5/1) progressively humified litter of past vegetation; very friable; abrupt smooth boundary
A	3–4	Very dark brown (10YR 2/2) silt loam; moderate very fine subangular blocky structure; very friable; many very fine and fine irregular packing voids; many very fine and common fine, medium and coarse roots; abrupt smooth boundary
Ap	4–19	Olive brown (2.5Y 4/4) silt loam with light olive brown (2.5Y 5/4) and olive brown (2.5Y 4/6) mixing zones occupying 30% of horizon; massive, parting moderately well to medium subangular blocky fragments where roots weaken cohesion; very friable to friable; few very fine tubular pores; common roots of all grades decreasing to few with depth; abrupt wavy boundary
Bw1	19–22	Light olive brown (2.5Y 5/6) silt loam occupying a lentil (50 cm wide) on right front face of pit (probably remnant of old Bw horizon that escaped mixing by plow) and as a smaller lentil on back pit face; massive; friable; few fine tubular pores; few roots of all grades; abrupt discontinuous boundary
Bw2	22–46	Light olive brown (2.5Y 5/4) silt loam; massive, but parting regularly along common very thin subhorizontal crenulated stress or depositional cutans to produce subangular blocky fragments; friable; common very fine and fine and few medium tubular pores, many of the fine ones are tortuous and possess stress cutans probably resulting from burrowing of organism (5 mm × 0.5 mm) observed in horizon; few medium and coarse root cork-lined pores; few roots of all grades; occasional very fine fungal strands exploiting tubular pores; 1 coarse spherical cavity filled with very porous Bw2 material; gradual smooth boundary
BC	46–67	Light olive brown (2.5Y 5/4) very fine sandy loam with common medium and large, faint clear olive brown (2.5Y 4/4; 5%) and olive (5Y 5/3; 5%) matric mottles; common very thin olive (5Y 4/3) cutans (as described for Bw2, though better expressed here) with few

		fine mangans concentrated around penetrating very fine roots and as discrete spots; massive, parting to coarse subangular blocks often with at least one face cutanized; friable; common very fine and fine tubular pores; few very fine, fine, and medium roots; few medium size very fine sand filled tubular krotovinas; two large Oe/Oa-A filled tubular krotovinas; one medium spherical cavity filled with BC material but exhibiting a sharp border; gradual smooth boundary
C1	67–112	Two very similar blotched light olive brown (2.5Y 5/4) and olive brown (2.5Y 4/4) fine sand zones, the upper part predominantly the lighter color and the lower the darker; with 3% (upper) to 10% (lower) medium and large distinct clear dark yellowish-brown (10YR 4/4) mottles adjacent to olive (5Y 5/3) zones, the pair most commonly occuring as quasiferrans and neoalbans around the few pores of living and dead roots; the two zones are broken at 91 cm by a nearly continuous 1.5-cm band of dark brown (7.5YR 3/4) oxidized and very weakly cemented fine sand; two other similar but very discontinuous bands are present in the upper zone; massive; very friable; very few fine tubular pores, very few very fine and fine roots; one medium-coarse spherical sand body (10 cm) observed at 74–84 cm; few cutanic surfaces observed (similar to those described for Bw2); gradual smooth boundary
C2	112–175+	Medium-coarse sand (A) interrupted by two complex finer zones (B) at 127–132 cm and 142–152 cm: (A) brown (10YR 5/3) sand (lower two sand members are borderline medium-coarse sand) with 5% medium distinct clear olive gray (5Y 5/2) matric mottles commonly with distinct clear yellowish-brown (10YR 5/6) and dark yellowish-brown (10YR 4/6) rinds (3–4 cm); some tubular pores containing dead roots exhibit neo-albans and quasiferrans similar to the mottles described previously in this entry; mottling in the second sand zone increases to 15% of pattern described; lower sand zone is nearly mottle-free; sample was taken from the upper sand zone (112–127 cm) (B) complex alternately dark brown (10YR 3/3) very fine sandy loam, finely mottled olive brown (2.5Y 4/4) loamy fine sand, finely mottled olive gray (5Y 5/2) silt loam; mottles in a given part are fine and medium, distinct to prominent, with colors as described for other parts of fine zone; massive; very friable (sands) to friable (loams); few very fine and fine tubular pores; no living roots observed

HADLEY very fine sandy loam
Site: 20
Taxonomic Class: Typic Udifluvent, coarse-silty, mixed, nonacid, mesic
Hydric Status: Nonhydric
Date Described: 19 October 1987
Location: Mount Hermon, Gill, Franklin County, Massachusetts

Horizon	Depth (cm)	Description
Oi	6–0	Relatively fresh leaf litter of predominantly maple and poplar; abrupt smooth boundary
Oe–Oa	0–3	Abundantly rooted dark brown (7.5YR 3/2 field moist) moderately and well humified litter of past vegetation; abrupt smooth boundary
AC	3–9	Dark grayish-brown (2.5Y 4/2) grading to olive brown (2.5Y 4/4) very fine sandy loam; massive, parting moderately to medium subangular blocky fragments; very friable; common roots of all grades; few very fine tubular pores; abrupt wavy boundary
Apb	9–25	Light olive brown (2.5Y 5/6) very fine sandy loam; massive, parting weakly to medium subangular blocky fragments; friable; common roots of all grades in upper part, decreasing to common medium and coarse and few very fine and fine in lower part; few very fine to medium tubular pores; abrupt wavy boundary
Bw	25–48	Light olive brown (2.5Y 5/4) very fine sandy loam (sandier than Apb), with common medium and large very faint clear light olive brown (2.5Y 5/6) and borderline grayish-

		brown to light olive brown (2.5Y 5/2-4) blotchy matric mottles; few roots of all grades; few very fine to medium tubular pores, the larger ones commonly have thin organs; clear wavy boundary
BC	48–74	Variable olive (5Y 4/4) very fine sandy loam and loamy very fine sand matrix with many medium faint clear olive (5Y 4/3) and olive brown (2.5Y 4/4) mottles; massive, parting very weakly to medium and coarse subangular blocky fragments; friable; <1% fine and medium gravel; few roots of all grades; few very fine, fine, and medium tubular pores, often having waxy cutans; 1 observed krotovina (15 mm) with loose humus interior; clear wavy boundary
C1	74–91	Olive (5Y 4/4) loamy very fine sand matrix with common medium faint clear olive (5Y 5/3) and olive brown (2.5Y 4/4) matric mottles and few medium distinct clear dark yellowish-brown (10YR 4/4) mottles associated with olive (5Y 5/3) matric mottles near base of horizon; one root associated neoalban (35 mm) with a distinct medium yellowish-brown (10YR 5/6) quasiferran observed; <1% fine and medium gravel with a slight concentration in a band at midhorizon level; gradual wavy boundary
C2	91–130	Olive (5Y 4/4) loamy fine sand–fine sand with many medium faint clear olive (5Y 5/3) and olive brown (2.5Y 4/4), common medium distinct clear dark yellowish-brown (10YR 4/4) mottles, with few medium distinct olive gray (5Y 5/2) zones adjacent to the latter; massive; friable; <1% fine and medium gravel; few very fine, fine, and medium roots; few very fine, fine, and medium tubular pores (in one a 2-mm insect larva was observed); gradual smooth boundary
C3	130–155	Grossly and diffusely bedded olive (5Y 4/4) loamy fine sand–fine sand and sand; loamy fine sand is like C2 horizon; sand has common coarse distinct dark yellowish-brown (10YR 4/4) matric mottles; abrupt smooth boundary
C4	155–180	Stratified coarse sand, fine and medium gravel, generally free of mottles though near top of horizon a few gravel poor strata are stained dark yellowish brown (10YR 4/6) where overlying a sharply contrasting gravel rich stratum

Appendix B. Soil Series—Range of Characteristics

Ranges in characteristics and geographic setting for soil series found in the Connecticut River valley as reported on the official soil series descriptions and forms 5.[1]

SACO Series

The A or Ap horizon has hues of 7.5YR through 2.5Y, values of 2 or 3, and chromas of 1 through 3. Texture is silt loam, mucky silt loam, very fine sandy loam, or mucky very fine sandy loam.

Individual layers of the C horizon are neutral or have hues of 10YR through 5Y, values of 3 through 6, and chromas of 0 through 2. Most layers within a 90-cm depth that have values of 5 or 6 and chromas of 1 or 2 are mottled. Included in some pedons are thin Ab strata. Texture of the C horizon to a depth of 120 cm or more is silt loam or very fine sandy loam. Below 120 cm, texture ranges from loamy fine sand through very coarse gravelly sand.

Saco soils are nearly level, very poorly drained on floodplains along rivers and streams. They are in depressed areas. In places, water is ponded on the surface from late fall through early spring. These soils flood in spring and after periods of heavy rainfall.
Flooding frequency: frequent.
Duration: brief.
Depth to water table: 0–15 cm.

LIMERICK Series

The A or Ap horizon has hues of 10YR through 5Y, values of 3 or 4, and chromas of 2 or 3. Textures are silt loam or very fine sandy loam, but lenses of loamy very fine sand or very fine sand may occur.

The C horizon has hues of 10YR through 5Y, values of 4 or 5, and chromas of 1 or 2 above 90 cm, and 1 through 4 below 90 cm. Mottles range from few to many and from faint to prominent; they are in shades of gray, brown, and red. Textures are silt loam or very fine sandy loam, but thin strata that vary in texture or color are common.

Limerick soils are somewhat poorly and poorly drained soils that occur on the floodplains of major rivers, their larger tributaries, or sometimes in the floodplains of smaller streams. They may be on broad flat areas or in fairly level shallow depressions. Most areas of the Limerick soils are flooded for several days each year, usually in late winter or early spring.
Flooding frequency: frequent.
Duration: brief.
Depth to water table: 0–45 cm.

[1]This information can be obtained from the local U.S.D.A. Soil Conservation Service office.

RIPPOWAM Series

The A or Ap horizon has hues of 10YR through 5Y, values of 2 through 4, and chromas of 1 or 2. Textures are fine sandy loam or sandy loam.

The B horizon has hues of 10YR through 5Y, values of 3 through 6, and chromas of 1 through 3. The horizon is mottled. The B horizon is sandy loam or fine sandy loam.

The 2C horizon has hues of 10YR through 5Y, values of 3 through 6, and chromas of 1 through 3. Texture ranges from loamy fine sand to coarse sand and may include thin strata of sandy loam, gravel, silt loam, and organic material.

Rippowam soils are nearly level, poorly drained soils on floodplains along rivers and permanent streams. These soils generally flood annually, mostly in spring.
Flooding frequency: frequent.
Duration: brief.
Depth to water table: 0–45 cm.

WINOOSKI Series

The A or Ap horizon has hues of 10YR through 5Y, value of 3 or 4, and chroma of 2 or 3. Texture is silt loam, very fine sandy loam, or loamy fine sand.

The C horizon has hues of 10YR through 5Y, value of 3 through 6, and chroma of 2 through 4. Texture is silt loam, very fine sandy loam, or loamy very fine sand. Some pedons have thin strata of very fine sand, fine sand, sand, or coarse sand below a depth of 120 cm. The thickness and number of horizons below the A horizon is variable and corresponds to the thickness and variability of the alluvial deposits. Depth to mottles with chroma of 2 or less ranges from 35 to 50 cm.

These soils are moderately well-drained, nearly level soils on floodplains. They are typically in broad depressions. They formed in recent alluvial deposits of very fine sands and silts. Flooding frequency varies from once or twice a year to once in 5–10 or more years. Stream overflow generally occurs in late winter or spring and during high rainfall.
Flooding frequency: common.
Duration: brief.
Depth to water table: 45–90 cm.

POOTATUCK Series

The A or Ap horizon has hues of 10YR or 2.5Y, values of 3 through 5, and chromas of 2 through 4. Textures are

very fine sandy loam, fine sandy loam, or sandy loam.

The Bw horizon has hues of 10YR through 5Y, values and chromas of 3 through 6. Low chroma colors occur above 60 cm. The Bw horizon is dominantly fine sandy loam or sandy loam, but includes thin strata of loam, very fine sandy loam, or silt loam. Some pedons have thin Ab strata.

The C horizon has hues of 10YR through 5Y, values of 4 through 6, and chromas of 1 through 6. It is typically mottled in some subhorizon. Textures of individual layers range from loamy fine sand through coarse sand. Some pedons have thin loamy or extremely gravelly strata.

Pootatuck soils are nearly level, moderately well-drained soils on floodplains along rivers and streams. Most areas of these soils flood for short periods each year. Soils on higher positions flood occasionally.

Flooding frequency: common or occasionally.

Duration: brief.

Depth to water table: 45–90 cm.

HADLEY Series

The Ap horizon has hues of 10YR through 5Y, values of 3 or 4, and chromas of 2 through 4. Dry value is 6 or 7. Texture is silt loam or very fine sandy loam.

The C horizons have hues of 10YR through 5Y, values of 3 through 6, and chromas of 2 through 6. Textures are silt to very fine sand to a depth of 120 cm. Some pedons have thin strata of loamy fine sand, fine sand, or sand. Below 120 cm, the texture ranges from silt loam to sand.

These soils are well-drained, nearly level soils on floodplains and high bottoms. Flooding by stream overflow ranges from once a year to once in 5–10 years. Flooding generally occurs during spring runoff or during high rainfall in fall. Floodwater seldom covers these soils for more than 2 or 3 days at a time on the high bottoms, but the duration is up to 7 days in the lower positions.

Flooding frequency: common.

Duration: brief.

Depth to water table: 120–180 cm.

Appendix C. Tabular Data for Vegetation at All Study Sites

Table C-1. *Weighted averages and index averages (mean values) for tree stratum by soil series and by sample site. For this study, sites where "averages" fell below 3.0 were considered to have hydrophytic vegetation.*

Soil series[a]	Site number	Drainage class[b]	Weighted average mean (std. error)	Index average mean (std. error)
SACO*	3	VPD	2.38 (0.24)	2.33 (0.24)
	6	VPD	2.09 (0.09)	2.05 (0.05)
	7	VPD	2.00 (0.00)	2.00 (0.00)
	11	VPD	2.00 (0.01)	2.10 (0.10)
	14	VPD	2.96 (0.04)	2.90 (0.10)
	15	VPD	2.84 (0.16)	2.90 (0.10)
	19	VPD	2.00 (0.00)	2.00 (0.00)
LIMERICK*	2	SPD	2.29 (0.15)	2.30 (0.12)
	5	SPD	2.63 (0.13)	2.47 (0.06)
	10	PD	2.00 (0.00)	2.00 (0.00)
	18	SPD	2.00 (0.00)	2.00 (0.00)
LIMERICK	1	SPD	2.33 (0.33)	2.33 (0.33)
	4	SPD	2.00 (0.00)	2.00 (0.00)
RIPPOWAM*	8	PD	2.33 (0.33)	2.33 (0.33)
WINOOSKI*	12	MWD	2.33 (0.11)	2.45 (0.13)
WINOOSKI	13	MWD	3.29 (0.14)	3.45 (0.13)
	17	MWD	3.67 (0.12)	3.72 (0.08)
POOTATUCK	9	MWD	3.98 (0.02)	3.90 (0.10)
HADLEY	16	WD	3.40 (0.25)	3.40 (0.25)
	20	WD	3.74 (0.11)	3.59 (0.08)

[a]* = hydric soil.

[b]Drainage classes: VPD = very poorly drained; PD = poorly drained; SPD = somewhat poorly drained; MWD = moderately well-drained; WD = well-drained.

Table C-2. *Weighted averages and index averages (mean values) for shrub stratum by soil series and by sample site. For this study, sites where "averages" fell below 3.0 were considered to have hydrophytic vegetation.*

Soil series[a]	Site number	Drainage class[b]	Weighted average mean (std. error)	Index average mean (std. error)
SACO*	3	VPD	2.00 (0.00)	2.00 (0.00)
	6	VPD	2.00 (0.00)	2.00 (0.00)
	7	VPD	2.48 (0.22)	2.46 (0.21)
	11	VPD	2.08 (0.07)	2.15 (0.10)
	14	VPD	2.09 (0.05)	2.35 (0.11)
	15	VPD	2.05 (0.02)	2.35 (0.12)
	19	VPD	2.03 (0.06)	2.00 (0.14)
LIMERICK*	2	SPD	2.38 (0.24)	2.38 (0.24)
	5	SPD	2.00 (0.00)	2.00 (0.00)
	10	PD	2.00 (0.00)	2.00 (0.00)
	18	SPD	2.00 (0.00)	2.00 (0.00)
LIMERICK	1	SPD	2.00 (0.00)	2.00 (0.00)
	4	SPD	2.00 (0.00)	2.00 (0.00)
RIPPOWAM*	8	PD	2.06 (0.02)	2.30 (0.08)
WINOOSKI*	12	MWD	2.08 (0.05)	2.18 (0.11)
WINOOSKI	13	MWD	3.71 (0.06)	3.17 (0.11)
	17	MWD	3.37 (0.16)	3.49 (0.08)
POOTATUCK	9	MWD	3.33 (0.13)	3.52 (0.10)
HADLEY	16	WD	4.05 (0.13)	4.03 (0.06)
	20	WD	3.57 (0.13)	3.57 (0.04)

[a]* = hydric soil.
[b]Drainage classes: VPD = very poorly drained; PD = poorly drained; SPD = somewhat poorly drained; MWD = moderately well-drained; WD = well-drained.

Table C-3. *Weighted averages and index averages (mean values) for herb stratum by soil series and by sample site. For this study, sites where "averages" fell below 3.0 were considered to have hydrophytic vegetation.*

Soil series[a]	Site number	Drainage class[b]	Weighted average mean (std. error)	Index average mean (std. error)
SACO*	3	VPD	1.75 (0.16)	1.90 (0.08)
	6	VPD	2.00 (0.00)	2.00 (0.00)
	7	VPD	1.94 (0.04)	1.81 (0.08)
	11	VPD	2.06 (0.11)	2.16 (0.10)
	14	VPD	3.96 (0.23)	3.89 (0.18)
	15	VPD	4.00 (0.38)	3.75 (0.21)
	19	VPD	1.85 (0.15)	2.00 (0.12)
LIMERICK*	2	SPD	2.00 (0.00)	2.00 (0.00)
	5	SPD	2.00 (0.00)	2.03 (0.03)
	10	PD	2.01 (0.00)	2.10 (0.07)
	18	SPD	2.01 (0.02)	1.93 (0.13)
LIMERICK	1	SPD	2.00 (0.00)	1.97 (0.08)
	4	SPD	2.00 (0.00)	2.00 (0.00)
RIPPOWAM*	8	PD	2.07 (0.07)	2.18 (0.17)
WINOOSKI*	12	MWD	2.03 (0.03)	2.23 (0.08)
WINOOSKI	13	MWD	3.97 (0.04)	3.95 (0.03)
	17	MWD	3.10 (0.24)	2.97 (0.17)
POOTATUCK	9	MWD	3.00 (0.08)	3.09 (0.15)
HADLEY	16	WD	3.49 (0.21)	3.50 (0.09)
	20	WD	3.72 (0.15)	3.63 (0.15)

[a]* = hydric soil.
[b]Drainage classes: VPD = very poorly drained; PD = poorly drained; SPD = somewhat poorly drained; MWD = moderately well-drained; WD = well-drained.

Table C-4. *Weighted averages and index averages (mean values) for combined strata by soil series and by sample site. For this study, sites where "averages" fell below 3.0 were considered to have hydrophytic vegetation.*

Soil series[a]	Site number	Drainage class[b]	Weighted average mean (std. error)	Index average mean (std. error)
SACO*	3	VPD	2.00 (0.12)	2.05 (0.07)
	6	VPD	2.03 (0.03)	2.02 (0.02)
	7	VPD	2.16 (0.10)	2.08 (0.11)
	11	VPD	2.05 (0.05)	2.14 (0.08)
	14	VPD	3.00 (0.07)	3.05 (0.05)
	15	VPD	2.96 (0.15)	3.00 (0.09)
	19	VPD	1.93 (0.08)	1.99 (0.08)
LIMERICK*	2	SPD	2.21 (0.07)	2.22 (0.08)
	5	SPD	2.27 (0.06)	2.22 (0.04)
	10	PD	2.00 (0.00)	2.03 (0.02)
	18	SPD	2.00 (0.01)	1.97 (0.05)
LIMERICK	1	SPD	2.10 (0.10)	2.07 (0.11)
	4	SPD	2.00 (0.00)	2.00 (0.00)
RIPPOWAM*	8	PD	2.12 (0.09)	2.26 (0.13)
WINOOSKI*	12	MWD	2.15 (0.05)	2.29 (0.06)
WINOOSKI	13	MWD	3.66 (0.06)	3.52 (0.05)
	17	MWD	3.38 (0.14)	3.39 (0.08)
POOTATUCK	9	MWD	3.44 (0.06)	3.50 (0.10)
HADLEY	16	WD	3.65 (0.10)	3.64 (0.06)
	20	WD	3.67 (0.10)	3.60 (0.08)

[a]* = hydric soil.

[b]Drainage classes: VPD = very poorly drained; PD = poorly drained; SPD = somewhat poorly drained; MWD = moderately well-drained; WD = well-drained.

Veneman, Peter L. M., and Ralph W. Tiner. 1990. **Soil–Vegetation Correlations in the Connecticut River Floodplain of Western Massachusetts.** U.S. Fish. Wildl. Serv., *Biol. Rep.* 90(6). 51 pp.

Vegetation along the Connecticut River floodplain in Massachusetts was sampled and analyzed to determine its association with known hydric and nonhydric soils. All soils subject to annual flooding—including those that did not have hydric characteristics—supported hydrophytic vegetation. This suggests that the regional wetland indicator status for certain species of vegetation may need to be reexamined.

Key words: Wetland soils, wetland vegetation, hydric soils, hydrophytic vegetation.

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